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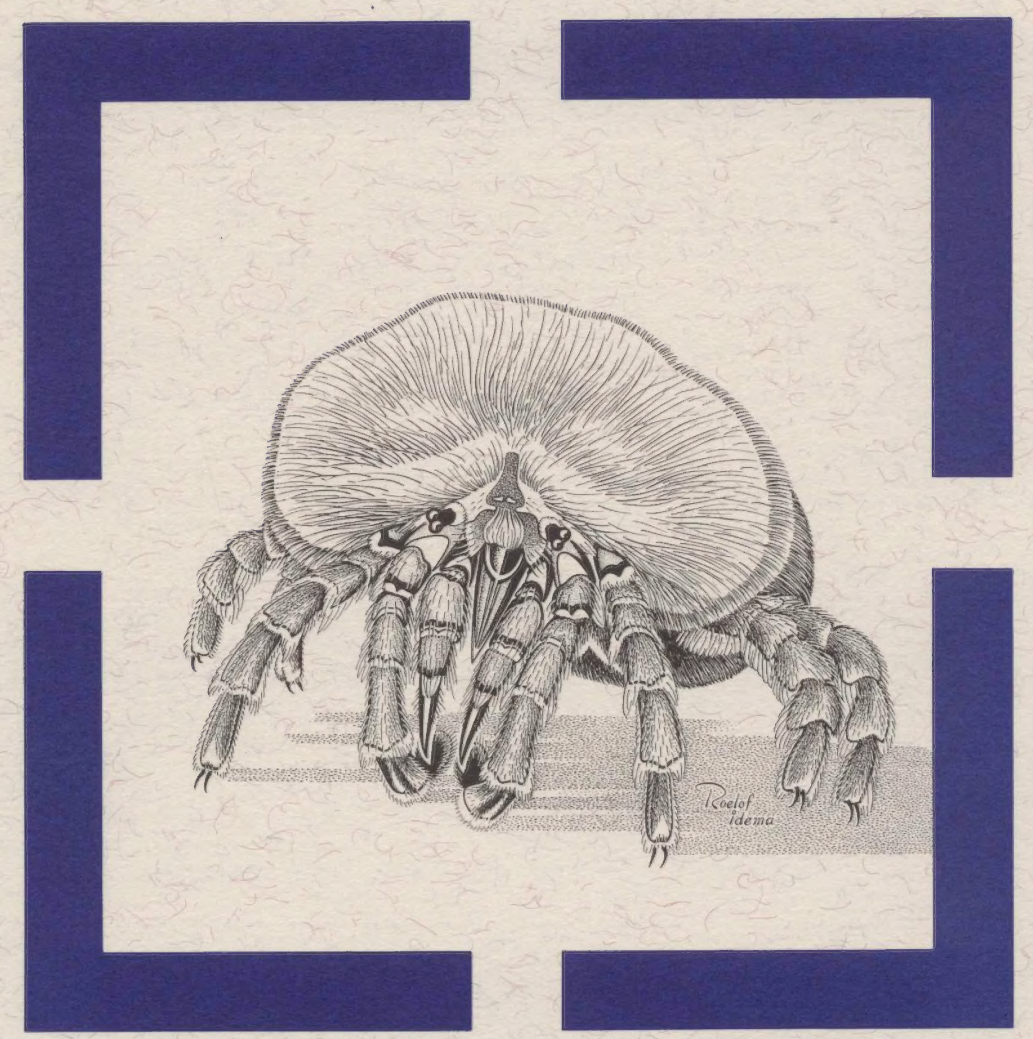
# CANADIAN BIODIVERSITY




An International Forum
on the Diversity of Life on Earth...
research, conservation, education and wise use

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## The goals of Canadian Biodiversity are to:

* *Publish articles, views and news on biodiversity*

* *Bridge the gaps amongst professional disciplines & the public*

* *Communicate information on Canadian & world biodiversity*

* *Express views on the needs & value of biodiversity research*

* *Discuss methods and philosophy of biodiversity conservation*

* *Review books and major articles on biodiversity*

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TABLE OF CONTENTS

AFTER RIO EDITORIAL . . . . . 2
Forging new global partnerships after Rio:
The key role of biodiversity . . . . . 2

PAPERS . . . . . 4
Biodiversity of Nearctic soil arthropods . . . . . 5
Arid grasslands - biodiversity, human society,
and climate change . . . . . 15
Biodiversity diamonds - the example of wild corn . . . . . 24

Illustration of common speargrass, *Stipa comata* Trin. & Rupr. . . . . 29

VIEWS . . . . . 30
Living inventions . . . . . 30
Canadian Biodiversity Resource Centre: A range of library sources meets a
diversity of needs . . . . . 34
The Rio Summit - Success or failure? . . . . . 35
Highlights of the WCED Statement . . . . . 39

NEWS . . . . . 40
Canada Ratifies Biodiversity & Climate Conventions and Appoints
Environmental Ambassador . . . . . 40
Canadian nominated to Senior United Nations Environment Post . . . . . 40
Scientific milestone: 4,000,000th plant specimen enters Missouri Botanical
Garden Herbarium . . . . . 40
1992 Biosystematics Resolution . . . . . 43
Book and Periodical Niche . . . . . 43

Illustration of the pea aphid mite, *Allothrombium pulvilum* . . . . . 49

Subscription to **Canadian Biodiversity** . . . . . 56

# AFTER RIO EDITORIAL

## Forging new global partnerships after Rio: The key role of biodiversity

*Maurice F. Strong*
*Secretary-General*
*United Nations Conference on*
*Environment and Development*

*presently*

*Chairman*
*and Chief Executive Officer*
*Ontario Hydro*

At the United Nations Conference on Environment and Development - the world's first-ever "**Earth Summit**" - in Rio de Janeiro from the 3rd to the 14th of June, 1992, major progress was made towards integrating environment and development. Much work still remains to be done, but the results achieved represent the most comprehensive and far-ranging programme of action ever agreed on by the world community. And that agreement was at the highest possible political level. In all, 182 countries were represented at Rio, with 105 Heads of State or Government in attendance. The results of Rio, as embodied in the Declaration of Rio, in Agenda 21 as a framework for a more sustainable 21st Century, and in the two new Conventions on Biological Diversity and Climate Change, provide the basis for a new global partnership which embraces rich and poor alike. It was particularly fitting that significant attention in Rio was focussed on Biodiversity. The conservation of biological diversity and the sustainable use of biological diversity resources could well play a key role in forging this new global partnership.

As agreed in Rio, the biological diversity chapter of Agenda 21 starts with the following statement, "The objectives and activities in this chapter of Agenda 21 are intended to improve the conservation of biological diversity and the sustainable use of biological resources, as well as to support the Convention on Biological Diversity." This latter point is particularly important. The convention, negotiated by an Intergovernmental Negotiating Committee under the auspices of UNEP, was one of the key outputs of the Earth Summit, which in turn helped to give both new conventions a prompt start with a record number of 153 countries signing them. Furthermore, in the Chapter, the signatories to the Convention on Biological Diversity now have available a comprehensive and action-oriented programme of activities. It calls upon governments, with the cooperation of relevant United Nations bodies and regional, intergovernmental organizations, the private sector and financial institutions and taking account of indigenous people and their communities to, for example:

(i) press for the early entry into force of the Convention, with the widest possible participation;

(ii) develop national biodiversity strategies and integrate them into national development strategies and plans;

(iii) implement measures for the fair and equitable sharing of benefits derived from research and development and use of biological and genetic resources;

(iv) carry out country studies;

(v) produce regularly updated world reports on biodiversity based upon national assessments;

(vi) recognize and foster the traditional methods and the knowledge of indigenous people and their communities, with particular reference to the role of women, to ensure that they can benefit commercially and economically;

(vii) implement mechanisms for the improvement, generation, development, and sustainable use of biotechnology and its transfer;

(viii) promote broader international and regional cooperation in furthering scientific and economic understanding of the importance of biodiversity and its function in ecosystems;

(ix) develop measures to enable countries of origin of genetic resources, particularly developing countries, to benefit from the biotechnological development and the commercial utilization of products;

(x) implement effective economic, social and other incentives to encourage conservation and sustainable use;

(xi) develop methodologies for the systematic sampling and evaluation of the components of biodiversity;

(xii) undertake better coordination on conserving endangered, non-pest migratory species;

(xiii) introduce various means for implementing the measures agreed, including the possible development of national biodiversity institutes or centres where they do not already exist.

These examples provide an indication of the comprehensive nature and range of the aims and activities upon which consensus was reached among all the countries represented at Rio. When considered together with the other chapters of Agenda 21, especially those on Combatting Deforestation, Promoting Sustainable Agricultural and Rural Development, the Environmentally Sound Management of Biotechnology, and the Protection of the Oceans, they constitute a global plan of action which is unprecedented in terms of its scale, relevance and achievability.

Nevertheless, hopes and expectations were not met in all areas. For example, no targets or dates by which measures should be implemented or for halting current rates of erosion of biodiversity were included in the document. And much more work remains to be done on the kind of "traditional" approaches to conserving biodiversity which have proved effective in the past, such as strengthening existing measures for protecting areas or expanding the networks of such areas. In spite of this, the agreements reached in Rio represent a major break-through, not least in terms of a political recognition that the sustainable use of biological resources would be a vital key to human development in the future. The prospect of improved food security, shelter and clothing, better health care and environmental protection, among other possibilities, made an important impression, not only among the world's leaders but on a huge audience around the world, reported by over 9,000 journalists that covered the Earth Summit. As United Nations Secretary-General Boutros Boutros-Ghali said in his closing address at the Conference: *"It is not enough for man to love his neighbour: he must also learn to love the world."*

It is more urgent than ever for the international community to follow through and to build upon what was agreed at the Earth Summit. History will base its judgement not on what happened in June 1992, but on what will be done in the years ahead to implement programmes in Agenda 21 and to put the new conventions into effect at various levels; local, national and regional, and by a broad range of organisations, governmental and non-governmental. It is now for Governments to translate it into their national Agenda 21s; for other institutions to do the same; and for each and every institution to adopt its own Agenda 21. Effective follow-up of the results of the UNCED process at the international level will depend upon the effectiveness of the proposed high-level Commission on Sustainable Development, which was agreed to in Rio and which is due to meet for the first time not later than 1993.

To ensure a truly successful follow-up on the conservation of biological diversity there is a need to new partnerships building on the global agreements reached at Rio and to expand the participatory processes which are so essential to their success. More than ever, this coming decade must accelerate the transition to a new pathway, one that is truly sustainable in economic as well las ecological terms. There is no area in which this is more important than in protecting the biological diversity of our planet - one of its most precious resources.

~ ~ ~ ~ ~

# *PAPERS*

## *Prologue on Life in Soils*

*One of the most unknown realms on this earth lies beneath our feet; the realm of the soil. Because of its network of roots, a portion of this realm is technically called the* ***rhizosphere*** *or root world. But the rhizosphere contains more than plant roots. Chief among these are mineral particles, water, air, humus and living organisms. Beyond the worms, most of the public is unaware of the amount, variety and significance of soil life. This includes mites, insects, round and earthworms, fungi, bacteria and dozens of other groups. These recycle nutrients, feed plants, moderate pest populations, fix nitrogen and provide many other ecological functions. A single gram of healthy soil can contain 100 million bacteria and several kilometres of fungal hyphae - threads which transmit nutrients to trees and other plants, and receive sugar in return. The healthy soil beneath a mature tree may contain enough fungal "threads" that, joined end-to-end, would circle the globe five times! What happens to this rich diversity and network of life when we plough and spray pesticides on our farms, clearcut the forests and burn the slash? Life in the soil sustains our crops, the grasslands and forests. We must learn about that life and sustain it.*

Collembola Neanura sp.

Collembola Isotomidae

# Biodiversity of Nearctic soil arthropods

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## *ABSTRACT*

*Knowledge of species diversity is the key to understanding natural and disturbed ecosystems. Documenting this diversity for soil arthropods is essential given accelerating global change, but presents problems because arthropods are both species-rich and phylogenetically diverse in soil habitats. Based on data from a variety of sources, 48 500 species of arthropods are expected to occur in North American soils, of which about 53% have been described. Acari (mites and ticks) comprise 35% of this anticipated diversity, while Diptera (flies) and Coleoptera (beetles) comprise 31% and 17%, respectively. Knowledge of the soil arthropod fauna varies extensively with taxa; most species of ants known from North America are described, whereas only 10% of the oribatid mite fauna is known. Immatures of less than 10% of the arthropod fauna are described. Species of oribatid mites known for North America are used as models to assess the completeness of taxonomic and biological information available for a major soil group; keys to species are available for only 51% of this known fauna, and data on feeding habits exist for only 10%. The mutual dependency of systematics and ecology is emphasized. Systematics provides the basis and predictions for ecological studies, ecology provides information on community structure and explanations for evolution.*

**Key words:** Arthropods - Biodiversity - Oribatida - Systematics - Ecology

Recently, the Council of Entomology Department Administrators of U.S. universities and research institutes recommended certain initiatives in entomological research which they deemed of immediate importance; among these was the issue of biodiversity (Anonymous 1989). The "biological diversity crisis" has received prime national and international attention as a result of worldwide deterioration of environments and associated extinction of many species and reduction of the genetic variability of others. Opinions differ on how to conserve this diversity, but all recognize that to assess its real importance, an inventory of the biota is needed. The necessity of an inventory as a basis for conserving biodiversity and monitoring global change is supported in the Sustainable Biosphere Initiative, proposed by the **Ecological Society of America** (Lubchenco et al. 1991). Knowledge of species and their relationships provides a common language for all biologists, permitting comparison of results between habitats and ecosystems, providing hypotheses to explain observed phenomena, and exposing the immense range of natural inventions (Danks 1988).

The problem of unknown biota is particularly acute for those who work with arthropods, because they are so abundant and diverse (Barnes 1989, Wheeler 1990). The most species-rich category of recorded living organisms is insects, and arthropods other than insects (i.e. spiders, mites, miilipedes, crustaceans and their relatives) are second only to plants in number of described species (Wilson 1988, Wheeler 1990). Extrapolations on the number of species worldwide vary from 5 to 80 million (Wilson 1988, Erwin 1988, Stork 1988), and most of these are invertebrates, primarily arthropods. As May (1988) noted, projections of potentially 30 million species of tropical arthropods based on research in the tropical forest (Erwin 1988, and included references) highlights our ignorance. We do not know the true number of extant species on earth within an order of magnitude. The dominance of arthropods among the world's animal species is a fundamental scientific insight, yet one not widely appreciated. Simply put, terrestrial and freshwater ecosystems would not function without arthropods (Wiggins et al. 1991).

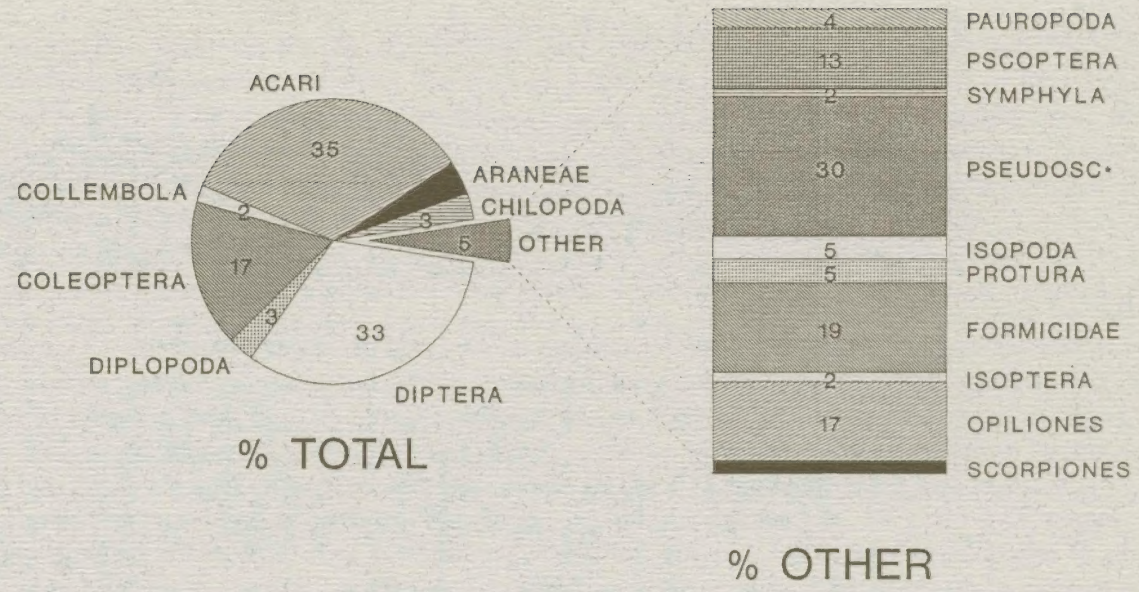


*Fig. 1 Diversity of North American soil arthropods. Percentage contribution of major arthropod groups to the total arthropod fauna. *Pseudosc = Pseudoscorpionida.*

## *BIODIVERSITY OF SOIL ARTHROPODS IN NORTH AMERICA*

In soil, in its broad sense including soil, litter, decaying wood and epiphytic microhabitats, arthropod species and phylogenetic diversity are exceptionally rich. In mature forest soils of temperate North America one would expect to find representatives of the following lineages, each of which reflects extensive divergence in body plan: 1 order of crustaceans, the Isopoda (sow bugs); 4 myriapod orders, the Chilopoda (centipedes), Diplopoda (millipedes), Pauropoda and Symphyla; 4 subclasses of Arachnida, the Pseudoscorpionida (pseudoscorpions), Opilionida (harvestmen), Araneae (spiders), and Acari (mites); Collembola (springtails), Protura, Diplura and Thysanura; and immatures and adults of several orders of insects, including Isoptera (termites), Psocoptera (book lice), Diptera (flies), Coleoptera (beetles), and Hymenoptera (bees, wasps, ants). This represents the greatest known phylogenetic diversity in any habitat, other than perhaps coral reefs.

As with other phyla represented in soil, knowledge of arthropod diversity varies in completeness. Recently the status and needs of systematics of North American insects and arachnids was reviewed (Kosztarab and Schaefer 1990), and a study of the diversity of nine groups of non-pterygote soil arthropods in Canada was completed (Behan-Pelletier 1993). Based partially on these reviews, modified following discussion with colleagues, 48,500 species of arthropods are expected to be represented in soils of North America, of which a little more than half (26,000 = 53%) have been described (Table 1). The groups that contribute most to this diversity are, Acari > Diptera > Coleoptera > Araneae > Diplopoda = Chilopoda > Collembola = Pseudoscorpionida > Formicidae > Psocoptera > Opilionida > Protura > Scorpionida > Isoptera (Fig. 1). Acari comprise over a third of soil arthropod diversity, closely followed by Diptera.

The state of our knowledge of a particular fauna varies extensively. The ratio of described to undescribed species is presented for certain groups in Fig. 2, based on data in Table 1. Beetles and spiders are well known. Waltz (1990) estimates that 80% of the Collembola fauna are known; O'Connor (1990) estimates that 17% of Acari are described, whereas we consider that only about 10% of the oribatid mite fauna are known.

| Taxa | Described | Undescribed | Total | % of N. American Fauna Known as adults |
|---|---|---|---|---|
| Isopoda* | 92 | 62 | 154 | 60% |
| Chilopoda* | 850 | 400 | 1250 | 68% |
| Diplopoda | 850 | 400 | 1250 | 68% |
| Paurapoda* | 70 | 47 | 117 | 60% |
| Symphyla* | 33 | 22 | 55 | 60% |
| Scorpiones | 90 | 10 | 100 | 90% |
| Aranae* | 1700 | 250 | 1950 | 88% |
| Pseudoscorpionida | 350 | 500 | 850 | 41% |
| Opiliones | 235 | 250 | 485 | 48% |
| Acari (Soil) | 2500 | 14500 | 17000 | 15% |
| Protura | 26 | 104 | 130 | 20% |
| Collembola | 700 | 250 | 950 | 80% |
| Isoptera | 41 | 1 | 42 | 99% |
| Psocoptera | 257 | 110 | 367 | 70% |
| Coloeptera (Soil) | 7400 | 1000 | 8400 | 87% |
| Diptera (Soil) | 10100 | 4750 | 14850 | 68% |
| Formicidae | 550 | ? | 550 | 98% |
| **Total** | 25844 | 22656 | 48500 | 53% |

* Estimated

***Table 1 Diversity of North American Soil Arthropods***

(Based partially on Kosztarab and Schaefer (1990) and Dindal (1990))

Kosztarab and Schaefer (1990) also summarized knowledge of immatures of insects and arachnids. For soil arthropods in general, immatures of 0 to 10% of the fauna are described in any group (Fig. 3). For example, though adults of 90% of the beetle fauna are described, larvae of only 10% are known (Arnett 1990). This is disturbing when one considers that immatures are often longer lived, more resistant to minimum levels of soil moisture, have higher metabolism, are often the main feeding stage, and thus the stage with greatest impact on ecosystem dynamics (Berthet 1964). Among insects, immatures are often the stage most active in soil. Some soil arthropods are paurometabolous, with immatures differing little from adults. But in the major (holometabolous) insect groups and the most diverse lineage of oribatid mites (the Brachypylina), immatures are morphologically very different from adults. Ecological studies on the soil fauna can yield high numbers of immatures, and much systematic and ecological information is lost when these remain unidentified and unidentifiable (see for example, Norton and Behan-Pelletier 1986).

## *EXTENT OF KNOWLEDGE OF SPECIES DESCRIBED*

We use knowledge of taxonomy and biology of oribatid mites as a model to address Barnes' (1989) pertinent question: what is the extent of knowledge of described species? We anticipate that other groups of soil arthropods would yield somewhat similar results. Thompson (1990) defined levels of taxonomic knowledge for North American Diptera; five of these levels are applied to the known oribatid fauna of North America, based on the species recorded in Marshall et al. (1987) (Fig. 4). Keys to species are available for 51% of the fauna. This implies that 49% of the fauna are known only on the basis of original species descriptions, which are often in specialized literature unavailable to general biologists. Of the 51% of the fauna for which

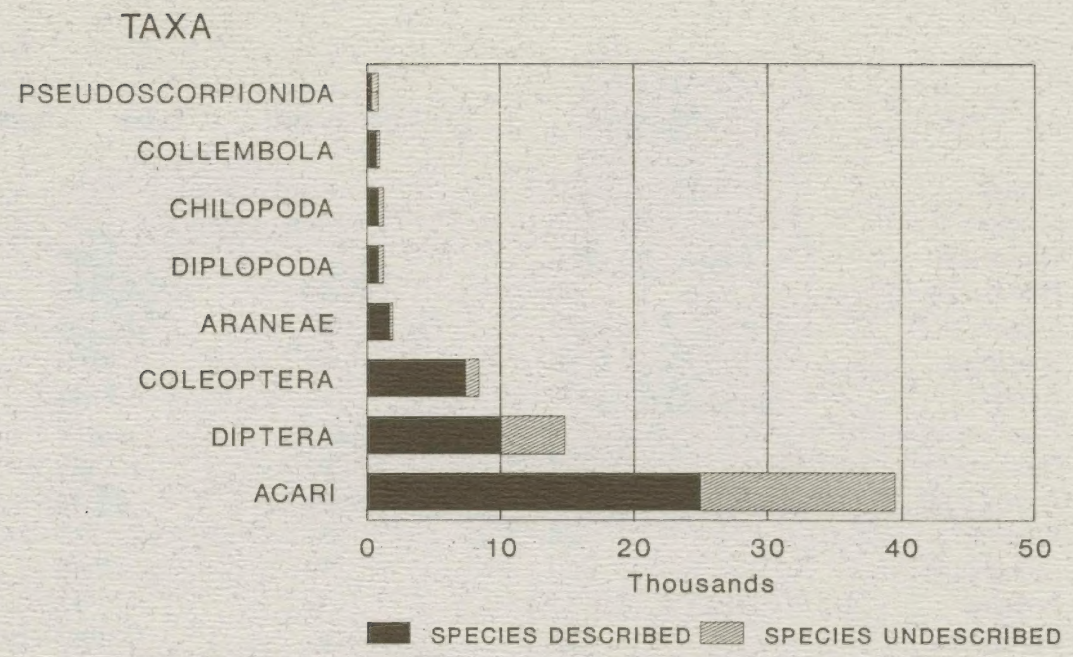


*Fig. 2 Ratio of described to undescribed species for selected arthropod groups in the North American fauna.*

keys are available, these are unreliable for 18%. Therefore, taxonomic data on only a third of described species of oribatid mites in North America are accessible to most ecologists. Non taxonomists often do not know the species with which they are working, with predictable results. For example, trying to understand why parasitic *Trichogramma minutum* Riley wasps released in a biological control program were increasingly less efficient, the entomologist in charge of a biological control laboratory in northern Peru discovered that he was rearing and releasing several species of wasps, rather than one, none of which was *T. minutum* (Dourojeanni 1990). Dourojeanni (1990) noted that when coping with biological diversity, non taxonomists have limited options: local identification, or sending material to specialists to be identified. Because of declining numbers of taxonomists, and the limited availability of comprehensive keys, there are problems with both approaches. Local identifications are often at the generic level and involve a high proportion of errors; material sent to specialists may take years to be available.

The extent of biological data on Oribatida, including information on morphology, ecology and feeding habits is given in Fig. 4. Whereas minimum ecological information is available (mostly habitat of original collection) for 70% of known species, data on morphology and feeding habits are available for less than 10% of species. These limited data on taxonomy and biology of oribatid mites mirror a similar analysis by Barnes (1989) on polychaete annelids, who concluded that "the animals that we know best are those at hand, those easiest to obtain and maintain in a laboratory ..... there has been some increase in the variety of species studied over the past thirty years, but much attention continues to be focused on a group of favorites".

Most of our information on biology comes from studies of a small cohort of species; many of these are eurytypic, often weed species, which encompass a suite of characters, physiology and behaviours potentially different from those of poorly studied, stenotypic species. In addition, information on even well-known species can be limited. For example, because techniques for observing the feeding habits of soil fauna have focused on organisms either in the water film or air space, studies exploring interactions between inhabitants of these coexisting microhabitats are rare (Walter and Kaplan 1990). Thus, biologists develop hypotheses and models based on knowledge of a fraction of the fauna. Autecological studies on feeding behaviour of soil mites have demonstrated the misinformation inherent to generalizations (Walter 1987, 1988, Walter and

Ikonen 1990). In a detailed study, Walter and Kaplan (1990) showed that although astigmatic mites in soil are generally considered fungivores, *Schwiebia rocketti* Woodring also can function as a hyperparasite, as well as prey on nematodes and protozoa. Adults and immatures of the oribatid species *Nothrus silvestris* Nicolet and *Platynothrus peltifer* (C.L. Koch), considered unspecialized feeders by Luxton (1972), were shown to prefer fungi and green plant remains respectively, because of differences in activity of carbohydrases in their guts (Siepel 1990).

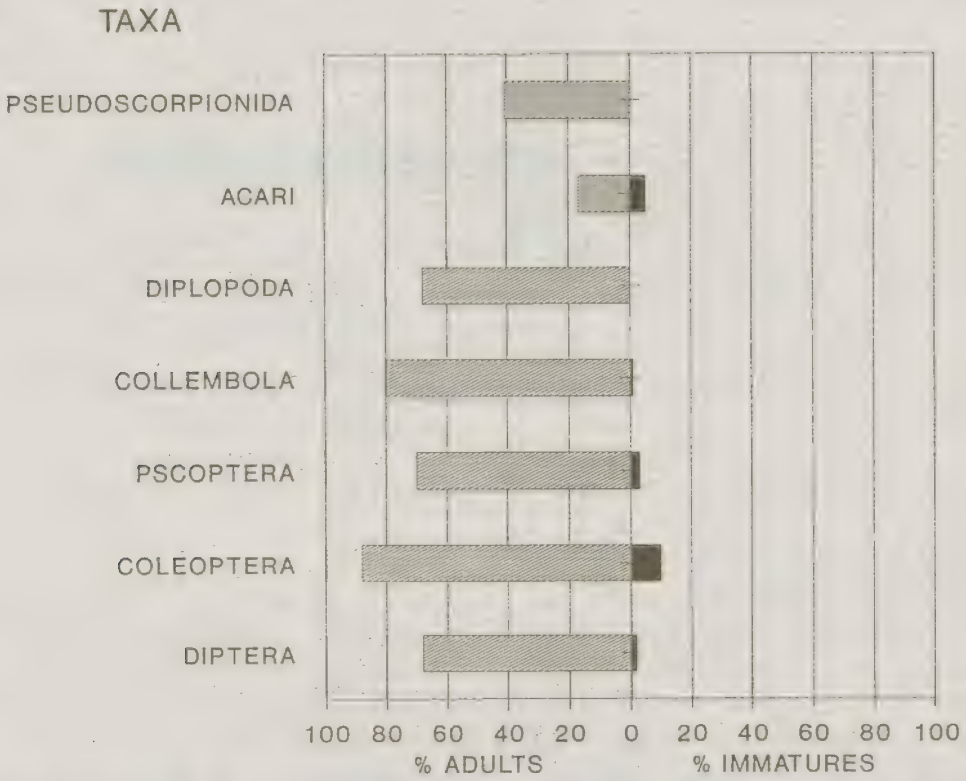


*Fig. 3 Percentage of adults and immatures described for selected arthropod groups in the North American fauna.*

## *HISTORICAL & BIOGEOGRAPHICAL INFLUENCES ON BIODIVERSITY*

Local community structure, the assemblage of species in a particular area, is a product of historical and biogeographical influences as well as ecology. For example, the known diversity of eleven selected groups of soil arthropods in Canada today is only a fraction of that of North America (Fig. 5). This is a product of historical factors, such as successive glaciations and plate tectonics, and ecological factors, such as recent extirpations, introductions, and the dominance of the boreal and arctic biomes (Downes and Kavanaugh 1988). Again, using Oribatida as a model, an analysis of the biogeography of species known to occur in Canada presents a more complex picture (Behan-Pelletier 1993). Oribatid species diversity in the western arctic and subarctic is high, containing species which are endemic or have Beringian distributions, and reflecting the high degree of historical influence on this fauna. Much of the western Canadian arctic and subarctic was unglaciated during the Pleistocene glaciations, unlike the eastern arctic and subarctic, which is otherwise similar. In addition, this western area was connected to the Palaearctic by the landmass of Beringia (about 2000 km long from north to south and wider from east to west) for long periods in the past (Matthews 1979).

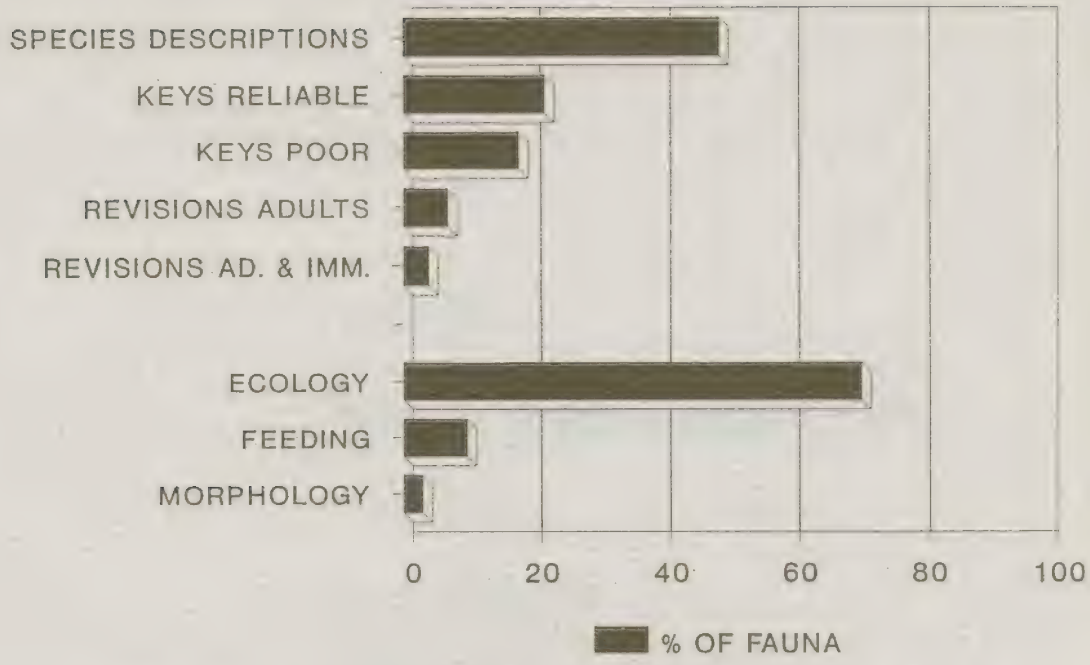


*Fig. 4 Taxonomic and biological information for described species of Oribatida of North America.*

## *SYSTEMATICS AND BIODIVERSITY*

Systematics is central to biodiversity. Without systematics, an inventory of biological diversity provides no more than a laundry list. Systematics searches for the relationships between taxa, and groups them into monophyletic lineages. Phylogenetic relationship is an indication of shared genetic history, and therefore potentially indicates similar abilities, or at least shared constraints on morphology, physiology and behaviour. A useful gene or gene product in one species signals a high likelihood of finding variants in closely related species (Goodman et al. 1987). Classifications based on phylogenetic relationships provide an evolutionary framework for testing various theories in any biological discipline (Norton et al. 1992).

While ecology has been maturing as an experimental and theoretical science, systematics has increased the rigor of phylogenetic explanations through the application of cladistics (Wanntorp et al. 1990). This in turn influences how ecologists approach problems. Inferences about many ecological and evolutionary processes require patterns as a reference for study, because patterns provide a directionality for studies on process. For example, a phylogenetic pattern indicates that cuticular mineralization evolved more than once in oribatid mites (Norton and Behan-Pelletier 1991), and so different processes may be involved. In the deeper soil horizons, and in soils in new and disclimax communities, the oribatid fauna often is dominated by parthenogenetic species whose reproductive mode is correlated with their ecology (Norton and Palmer 1991, Norton et al. 1993). In contrast, the aquatic oribatid mite, *Mucronothrus nasalis* (Willmann), is parthenogenetic because of phylogenetic constraints, not as an adaptation to its environment (Norton 1992).

For most soil arthropod groups there is a lack of detailed phylogenetic hypotheses against which other hypotheses can be tested. But advances in systematics and ecology must progress in tandem: systematics providing both the basis and predictions for ecological studies, and ecology providing information on community structure, and explanations for recent evolution and adaptation.

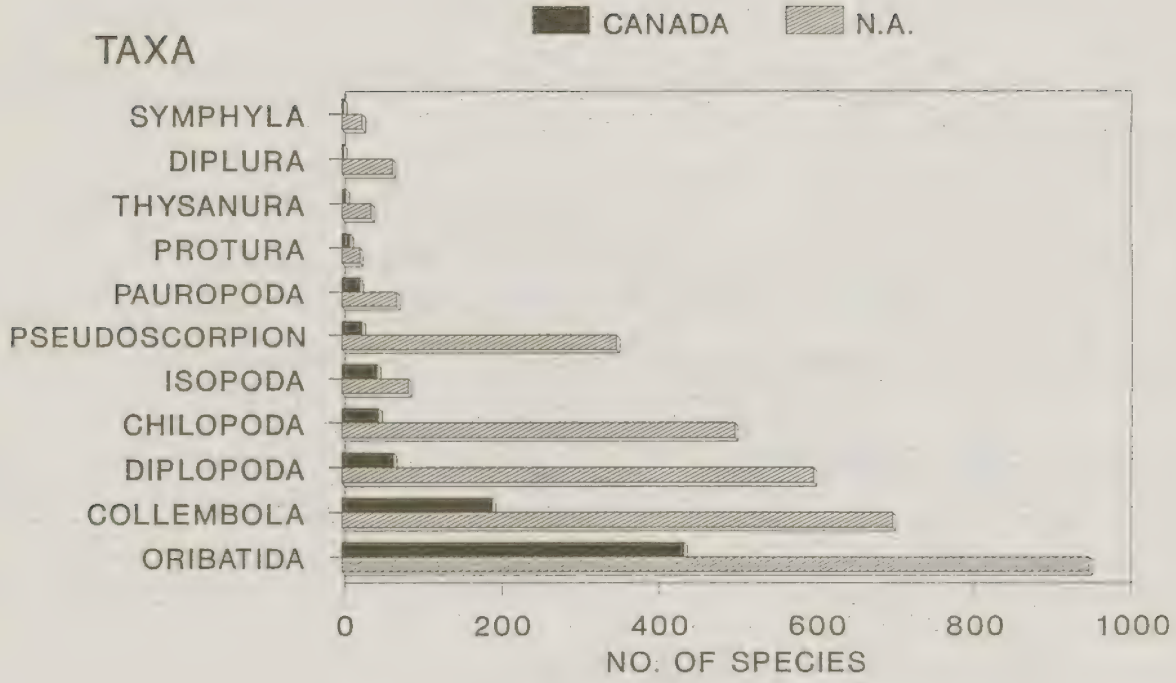


*Fig. 5 Comparison of the species diversity of selected groups of soil arthropods in Canada with the total diversity in North America.*

## *CONCLUSIONS*

With about half of the species of arthropods in North American soils described at least on the basis of adults, the goal of an inventory of biodiversity is not as daunting as in the tropics. The priorities should be the taxonomy of adults and immatures of undescribed species, synthesis of taxonomic knowledge in monographs and keys so that it is available to biologists, autecological research to establish the functional role of soil animals, and integration of both into studies of ecosystem level processes.

Systematics and ecology are mutually dependent disciplines. This often repeated statement (Stanton and Lattin 1985, 1989), has been reiterated recently by Funk and Pipoly (1990). Their suggestions for how systematics and ecology can work together to broaden the biodiversity agenda are appropriate for soil biologists: inventory data from study sites, using standardized sampling methods to provide a baseline for future studies; cooperate on the strategic placement of sites for surveys of the biota; use phylogenetic information to pose more meaningful questions about mechanisms of evolution; recognise that systematics and ecology provide information on the life history of organisms from two different perspectives, pattern and process.

## *ACKNOWLEDGMENTS*

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needle-and-thread poverty oat grass little bluestem big bluestem wheat grass blue grama

# Arid grasslands - biodiversity, human society, and climate change

*Quantifying biotic responses associated with anthropogenic change, a prerequisite for interpreting biotic shifts in long-term climate change research.*

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## *INTRODUCTION*

The number and abundance of species, biological diversity, and the way in which individuals of component species interact to form an ecosystem is one of the least understood dynamics in nature. Ecosystems are under pressure on a global scale that is without precedent in historical times. Humans are an integral element in ecosystems and are the agents responsible for large scale artificial systems[1] such as agroecosystems, urban and industrial environments. Human culture and ideology form the basis of the interaction of humans with ecosystems. The nature of this interaction is defined by our ability to manipulate the environment, mediated by culture and modified by the environmental response. The triple effects of this interaction - environmental degradation, ecological fragmentation and the introduction of exotic biota; are responsible for the current global reduction in biodiversity. Potentially, a fourth effect of the interaction of human society with ecosystems, is climate change. The greatest impacts on biodiversity are expected to be associated with climate change; global warming will act as a synergist, exacerbating the above mentioned effects. Large scale epizootics and epiphytotics, already a part of the changing environment, can be expected to have a devastating influence on existing ecosystems, on agriculture systems, and on human society. Ecological fragmentation and the associated impediments to biotic dispersal will act to prevent organisms from migrating

[1]Artificial ecosystems are defined as those ecosystems that would not exist without human intervention.

with changing conditions, resulting in mass extirpations as local conditions change within these fragmented ecosystems. The need for baseline data on our ecosystems has never been more acute than at present. In order to predict and manage the human and biotic shifts likely to be associated with climate change, baseline information on present and past ecosystems is essential. The arid grasslands of western Canada form an ecosystem in which the impact of this interaction has already profoundly affected both human and biotic components. The mixed prairie grasslands provide an opportunity to examine the consequences of the greatest destruction of biodiversity known in Canada and to acquire the baseline data upon which hypothesis and models concerning the grasslands system can be structured.

## *GRASSLANDS*

Canada, with the exception of several refugia, was essentially devoid of biota at the time of the Wisconsinan glacial maximum, 18 ka [thousand years before present] (Matthews 1979). At that time the grasslands occupied a position on the Texas-Mexican border (Ross 1970). Since then, biota have reinvaded Canada, predominantly from the south, more or less following the glacial retreat (Downes and Kavanaugh 1988). The boreal forest closely followed the retreating glaciers in midwestern Canada; it was not replaced by grasslands until 11-10 ka (Ritchie 1989, Schweger 1989). Climatic and biotic distribution data indicate past warm, dry periods, culminating with the mid Holocene Hypsithermal Interval and followed by gradual decreases in temperature and aridity to present conditions (Anderson, Mathewes & Schweger 1989). The period of maximum warmth and aridity (8-6 ka) corresponds with the northern limit of grasslands. The cooler, wetter conditions that prevailed since then have allowed the boreal forest to move south, reinvading the northern margins of the grasslands, more or less establishing present boundaries (Klassen 1989).

*Brave Dog Society, Blackfoot, 1910. H. Pollard Collection, Provincial Archives of Alberta. Indigenous people were eventually restricted to reserves.*

The grasslands of western Canada are complex ecosystems. Grasslands occur in areas where there is insufficient soil moisture to sustain trees over the growing season (North 1976, Walter 1985). Trees and bushes within grasslands are associated with wet depressions, riparian and dune habitats. The southern portions of these grasslands in Canada are drained by the northernmost tributaries of the Mississippi watershed: the Milk and Frenchman Rivers. Because of this drainage pattern and the mid Holocene Hypsithermal when biota moved northward, this area contains biotic components usually associated with more southern habitats. Mixed Prairie is the most extensive of the four grassland associations found in western Canada. It is nearly sympatric with the brown and dark brown soil zones of southeastern Alberta and southwestern Saskatchewan (Coupland 1973). The southeastern grasslands of Alberta support over 560 species of vascular plants (Moss and Packer 1983) and an unknown number of fauna. Various government reports (Brierley, Bradshaw and Downing 1989; Wallis 1976; Wershler 1980) have documented the vertebrate fauna but provide only cursory surveys of the invertebrates. The 61 species of mammals reported from southeastern Alberta (Smith 1986) are dwarfed by the estimated 6-8,000 species of arthropods. A recent estimate of arthropod biodiversity in Canada suggests about 66,000 species may be present nationwide (Danks 1979), a substantial portion of that fauna can be expected to occur in the arid grasslands.

*Cochrane Lakes round-up, 1905. H. Pollard Collection, Provincial Archives of Alberta. Early federal policies promoted ranching in the grasslands.*

## *RECENT HUMAN INFLUENCE*

In 1870 the Hudson Bay Company transferred its territories to the new Dominion of Canada. This is a landmark date for the grassland ecosystems of western Canada. Jones (1987) documents much of the history of western settlement in the prairie dry belt. Within a period of 50 years dating from land transfer, the prairie dry belt was transformed from native prairie to the most altered ecosystem in Canada. The federal government developed policies designed to promote the settlement of the west by Europeans who were

engaged in agrarian activities. At the same time, Indian Affairs policies were designed to effect a parallel transformation in the economies and societies of indigenous people; they were eventually restricted to reserves. Wild bison were extirpated. Ranchers moved in with their cattle, but by 1910 both were largely replaced by settlers intent on farming. By 1915 vast tracts of land, 2.7 million acres (1.1 million hectares) in southeastern Alberta alone, had been converted to European style agriculture in the dry belt of the prairies.

*Homesteaders shack, 1918. H. Pollard Collection, Provincial Archives of Alberta. By 1910 ranchers were largely replaced by settlers intent on farming.*

The effect of settlement was to restrict the existing diverse grassland ecosystem to small areas, replacing these with simple agroecosystems of few species over large areas. The processes of ecological fragmentation and the introduction of exotic biota were conducted with great speed and success until drought conditions began to prevail in the twenties. The dust storms of the twenties and thirties are directly attributable to a reduction in biodiversity due to ecosystem degradation resulting from agricultural mismanagement over large areas of land. Maintaining the original grasslands would not have prevented drought, but rather that the secondary effects of drought would have been quite different. Specifically, the root mass of a complex, drought-adapted grassland ecosystem would have prevented soil erosion due to wind. The resulting preservation of top-soil would have allowed for rapid recovery when drought conditions were alleviated. Instead, 60 years after the event, the area affected in the dust-bowl has still not recovered. A soil environment 10,000 years in development was lost in a few dry years. The loss of soil flora and fauna, necessary for unaugmented nutrient cycling, is incalculable, both in terms of organisms and dollars.

The human cost (Jones 1987) from this reduction in biodiversity, in this case precipitated by agricultural practice was high. Unethical land speculation, and drought led to thousands of displaced people; hundreds of thriving communities reduced to ghost-towns; bank write-offs which in the period 1920-1926 totalled over

$3.2 million (about 1 billion in 1992 dollars); the failure of banks (Union Bank of Canada); huge losses to mortgage companies with repercussions as far away as New York (Associated Mortgage Investors of Rochester); formation of a politically active United Farmers Association; a change in provincial government; the near collapse of the provincial financial system; the infusion of massive federal and provincial aid; the first socialist-style debt restructuring in North America; initiation of large scale water diversion projects; the first large provincial deficits; provincially backed systems of farm credit which still exist today; and the Special Areas Program designed for administration of the arid grassland region which remains agriculturally marginal to this day.

*Wheatfield at Rockyford, Alberta, 1920. H. Pollard Collection, Provincial Archives of Alberta. The diverse grasslands ecosystem was replaced by simple agroecosystems of few species over large areas.*

So catastrophic were the effects of drought, that it forced a reconsideration of the human role and presence in grasslands. Dryland farming specialists began to search for more sustainable forms of agriculture. Much of the area reverted to ranching, and irrigation assured continued crop yields where water and finances permitted (Jones 1987). Even so, biological diversity and its relationship to ecosystem dynamics and human society in the grassland system, remains unrecognized. For instance, Coupland (1973) notes that continued grazing leads to the invasion of unpalatable exotic species, a reduction in vigour of plant cover, water loss on exposed soil surface, compacted soils, and tends to favour species of drier regions. Quinn and Walgenbach (1990) note the relationship between grasshopper communities, grazing history, grass coverage and species richness of grasses in a mixed-grass prairie community. Pfadt (1984) also found greater diversity of grasshoppers associated with relatively undisturbed mixed grass prairie. Bradley and Smith (1986) note the relationship of flood control (reservoirs of water for irrigation) to survival of the plains cottonwood, *Populus deltoides*, and by implication the treed ecosystems of floodplains in grasslands. Robertson (1984) discusses the relationship of irrigation to soil salinity and ammonia fertilizers to soil acidification. Potter and Meyer (1990) found that soil structure degrades easily if biological activity falls below a minimum threshold

level. They also note that arid soils differ in microbial diversity from other soils, and demonstrate specific trends in microbial diversity with respect to management practise. From these studies it is reasonable to conclude that sustainability of current grassland agricultural practices is questionable. If the way in which individuals of species interact to form a stable ecosystem is unknown, history demonstrates that it is not only presumptuous, but costly, to manipulate that system.

*Dust bowl farmer, 1929. Photographic collection of the Provincial Archives of Alberta. A soil environment 10,000 years in development was lost in a few dry years.*

## *BIODIVERSITY AND CLIMATE CHANGE*

The structure and dynamics of grassland ecosystems, as measured by biological diversity, are constantly changing in response to environmental trends and human intervention. Drought in the prairies is associated with the position of the arctic front, a northward shift of the mean summer position produces a hot drought while a southward shift produces a cold drought (Ball 1992). The Hypsithermal Interval, associated with increased aridity and a northward shift of the grassland ecosystems, produced temperatures exceeding any that can presently be attributed to climate change. The cold drought of 1815-1817 produced temperatures well below present norms. The use of fire by pre-European Indigenous societies served to maintain grassland systems in marginal areas (Lewis 1982). However, ecological fragmentation associated with western settlement has had quite a different effect. In order to interpret changes that may be associated with future climatic shifts, it is necessary to document and understand the consequences of past and present processes.

Fragmentation of the ecosystem by agriculture subdivides populations and imposes barriers to dispersal. The latter acts to limit gene flow and preclude migration as a response to environmental change (Ledig 1992). In grasslands, particularly in western Canada, fragmentation serves to restrict biota to the agriculturally inaccessible riparian zones. The effect of habitat fragmentation on gene flow within populations restricted

to these agricultural refugia is unknown, but it is of importance both to conservation and the outbreaks of pest and disease organisms. These fragmented populations contain only a part of the original gene pool and are often subject to substantial genetic drift and loss of genetic diversity (Brown 1992). Geographically circumscribed species with little genetic diversity have proven highly prone to extinction (Ehrlich 1992).

Climate change scenarios (Fodchuk 1989, Harrington 1987) indicate that a future climate tending toward more xeric conditions is likely to prevail in the arid grasslands of western Canada. The consequences, in human and biotic terms, of climate change in an agriculturally marginal, fragmented ecosystem could be catastrophic. Without knowledge of the physical processes that mould the environment, their influence on past ecosystems, and without baseline information on present ecosystems we will be unable to place climate-mediated human and biotic shifts in perspective. In short, we will be in the position of reacting to climate change rather than understanding and managing its impact.

The importance of basic research in biodiversity and its relationship to ecosystem dynamics and human society cannot be understated. It is an unfortunate truth that most of the benefits derived from diverse relatively stable ecosystems are not evident until that ecosystem is modified. The arid grasslands ecosystem has been so altered by recent human influence that it is no longer possible to find pristine examples of the habitat. An assemblage of species different from that of the recent past now constitutes the grasslands ecosystem. Habitat fragmentation, the introduction of exotic biota, and habitat degradation in grasslands have resulted in an ecosystem already in disequilibrium with current climate; so and as Westman (1990) notes, any human manipulation of relative abundances of species must take place within that context. The biodiversity crisis demands a proactive problem solving approach and calls for close links between research and management (Western 1992). For instance park reserves face special management problems, with respect to rare species. Climate change will probably force these species to migrate, yet few are capable of crossing barriers like cities, roads, reservoirs and farmland (Tangley 1988). In addition to documenting change within parks, consideration should be given to opening northward corridors for biotic migration and shifting park boundaries in response to climate change if ecosystems are to be maintained with current species assemblages. Baseline information on existing ecosystems, coupled with the historical perspective will provide the foundation on which informed management decisions can be based.

***Most of the benefits derived from diverse relatively stable ecosystems are not evident until that ecosystem is modified.***

## *CONCLUSION*

The arid grasslands ecosystem has historically proven to be highly sensitive to change, both climatic and anthropogenic. Human society and the biota presently existing in the arid grasslands ecosystem reflect that history. Ecosystem fragmentation, degradation, and introduction of exotic biota, associated with agriculture practises of western settlement, have wrought profound transformations in the grassland ecosystem. The advent of climate change is expected to precipitate further reductions in biodiversity as well as substantially alter the arid grasslands ecosystem. Knowledge of past processes and their influence on former ecosystems are necessary to place any future human and biotic shifts in perspective. Knowledge of the biotic and abiotic changes associated with human society provide the foundation for development of models on which to base

predictions of ecosystem response to climate change. Baseline data on the biotic and abiotic components of present grassland ecosystems must be acquired. In doing so the biotic nuances associated with human interaction will be quantified, permitting clarity in assessment, and informed management of biotic and human shifts mediated by climate change.

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# Biodiversity diamonds - the example of wild corn

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There are many reasons why biodiversity should be preserved, including: the economic importance of living resources; indispensable ecosystem services such as purification of water, air and soil, and regulation of climate; aesthetic values, not the least of which is living in a clean, healthy, attractive, and interesting environment; educational benefits, particularly how successful species teach us how to survive and thrive; recreational activities; and ethical issues, such as respect for life in all of its forms. In this article we briefly examine just one economic aspect of biodiversity, the value of wild germplasm as exemplified by corn.

In a recent issue of *Canadian Biodiversity*, McAllister and Whiting (1992) referred to important plant domesticates like corn, beans and tomatoes as "biodiversity gold." Indeed, gold has frequently been used to characterize nature's gifts to mankind, and natural ecosystems are often described as "gold mines". In the following, we explain why we think diamonds are sometimes a better analogy than gold for describing some of nature's wild genetic treasures that can profoundly improve the welfare of mankind. And, we emphasize that unless the continuing adulteration of wild habitats is restrained, many of these diamonds could be lost forever, even before their discovery.

The converse of biodiversity is bio-uniformity, and this may be extremely dangerous within species. The most infamous example of the danger of genetic uniformity was provided by the great Irish potato famine (1845-1848). Until 1851, all of Europe's potatoes were descended from only two 16th century collections, and were therefore extremely uniform genetically. The Irish potato crop was literally annihilated by a fungus, late potato blight, which led to widespread starvation (perhaps 2.5 million died) and social upheaval (2.5 million emigrated). Since then, it has become evident that modern crops are in a genetic arms race against insects, pathogens and weeds, and to thrive require regular genetic rejuvenation, especially by breeding with wild relatives. The discovery of a dwarfing gene in a wheat variety is credited with literally saving over 100 million people from starvation (Witt 1985), preventing a disaster considerably exceeding the Irish tragedy. Corn (usually called maize in the Old World) provides another example of the dangers of bio-uniformity. In 1969-70, southern corn leaf blight caused over a billion dollar loss to the U.S. corn crop, which had become vulnerable because of genetic uniformity.

Authorities differ on whether rice or corn is the world's second most important crop after wheat. In any event, with an estimated annual harvest value of 55 billion American dollars, corn certainly ranks as one of the supercrops that feed the world. There are many examples of discoveries of wild relatives of crops that have furnished germplasm for genetic improvement. However, because of the economic status of corn, and also because it is such an interesting tale, the following story about corn has become a classic.

Modern domesticated corn, the annual species *Zea mays*, has several wild relatives, all popularly called "teosinte". One of these, *Z. perennis*, was discovered in Mexico near a railroad station in 1910, but could not be found again after 1921. For many years the corn specialist and conservationist Hugh H. Iltis of the University of Wisconsin attempted to find this plant in its native habitat, and in 1976 he mailed colleagues a New Year's card with a drawing of the elusive species. Maria Luz Paga, a botanist at the University of Guadalajara, received one of the cards and challenged her students to find the wild corn. An undergraduate,

Rafael Guzmán, succeeded not only in discovering a wild location of *Z. perennis*, but also in collecting an unknown wild related species, now called *Z. diploperennis*, in southern Mexico. Later studies by Iltis and co-workers established that the wild *Z. diploperennis* occurred at only four natural sites (Benz 1990). The new species proved to be resistant to five of the nine major virus diseases affecting cultivated corn, and was found to be the world's only source of resistance for three of these. Morover, *Z. diploperennis* was observed to have the same chromosome number as corn, and to cross easily with it, unlike the only previously known perennial *Zea, Z. perennis*. Not only does this mean that wild genes of *Z. diploperennis* can easily be transferred to corn, but also so can the perennial character, so that in warm-climate areas a perennial corn can be bred, and a form of low-input sustainable agriculture may be established. The drought-resistant and disease-resistant genes of *Z. diploperennis* have been estimated to have a potential value of 4.4 billion American dollars annually worldwide for breeding improved corn (Witt 1985). Without the timely interest in wild corn by a very few dedicated scientists, *Z. diploperennis* could easily have been neglected to the point of extinction. Dr. Iltis seems to have a Midas touch, for in 1962 he and a colleague collected a wild Peruvian tomato whose genes have been estimated to have value for the improvement of tomatoes of 8 million American dollars annually.

*Figure 1.* *Left: Ear of a wild species of corn,* ***Zea diploperennis****. Note single row of hard kernels. Right: Ear of modern corn.*

With the specific intent of conserving the wild habitat of *Zea diploperennis*, a 139,000 ha nature area, the Sierra de Manantlán Biosphere Reserve, was created in 1987 (Guzmán and Iltis 1991), one of only a few preserves in the world established specifically to maintain wild germplasm related to crops. It is instructive to consider what the natural conservation of this single wild species of corn has meant to the preservation of biodiversity. *Zea diploperennis* occupies less than 0.2% of the area of the park, and so has been the stimulus for the defence of many other species. Within the area of the Mexican preserve there are over 1,800 other species of flowering

plants, to say nothing of jaguars, ocelots, parrots, and thousands of other animal species. By preserving a small proportion (ca. 0.07%) of the area of Mexico for a single species, a sizable proportion (ca. 9%) of the huge flora of Mexico has also been given protection. In Canada, there is excellent potential for employing national parks as *in situ* genebanks for perhaps 400 indigenous species of potential economic value (Prescott-Allen and Prescott-Allen 1984). For wild plants, wild preserves are usually much to be preferred over seed and garden preservation, because of the difficulty and expense of maintaining much diversity under artificial circumstances. It should not be thought, however, that existing parks in Canada and elsewhere would suffice, even if they acquired the status of genebanks, since wild relatives of crops are known to occur in many areas outside designated parks. It has been estimated that only 1% of the world's biodiversity occupies designated park areas (Roberts 1988).

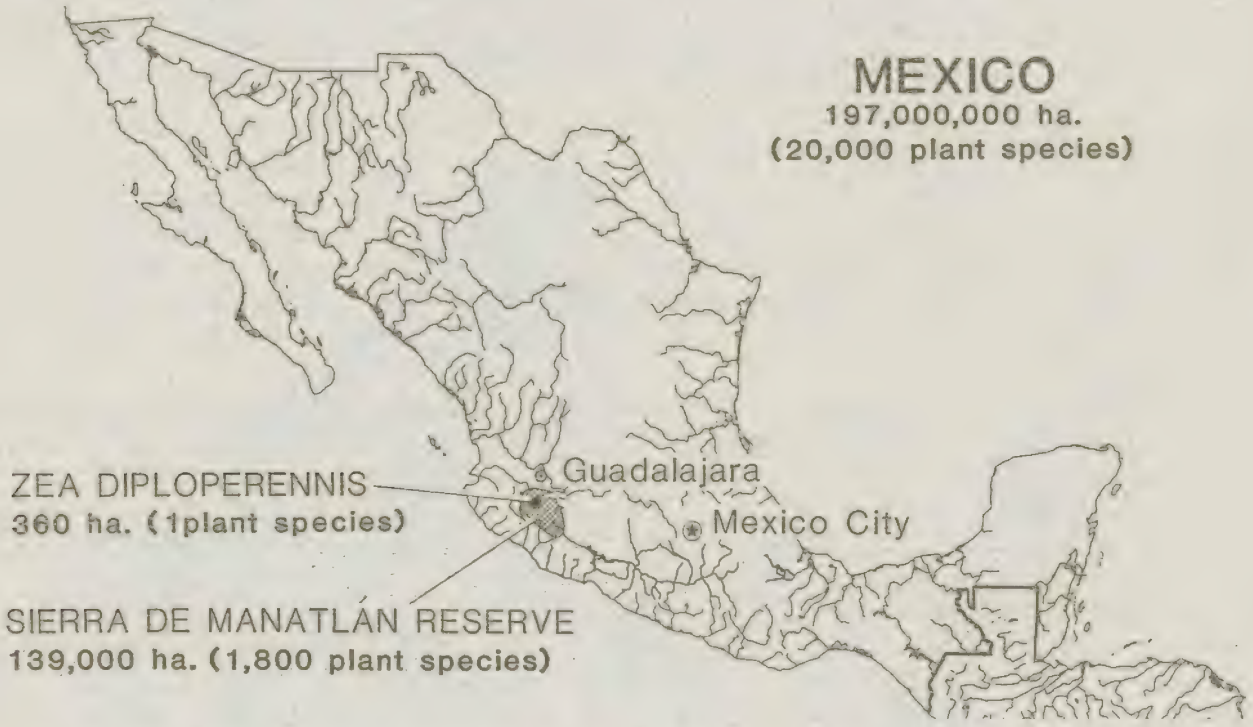


*Figure 3. Map of Mexico showing the Sierra de Manantlán Biosphere Reserve, dedicated to preservation of the valuable wild corn* ***Zea diploperennis****. Note that considerable additional biodiversity has been protected as a consequence.*

Certainly the analogy that biodiversity is like a gold mine - for food, fibre, wood, medicine, and industrial raw materials, has much to recommend it. However, natural deposits of gold are usually impure, requiring gradual accumulation and refinement. By contrast, diamonds have been refined by nature, much like the genes present in wild species. Despite their apparent strength, like fragile species in nature, diamonds can be destroyed much more easily than gold. The search for diamonds like the search for germplasm is often more like looking for a needle in a haystack than mining or panning for gold. And diamonds have very different values depending on market demand, just as the economic value of the crops that can be improved by wild germplasm differs enormously.

The analogy can even be made that, as with the synthesis of genes in the laboratory, some diamonds can be manufactured, although nature furnishes a much more varied and abundant supply. The viewpoint has been

expressed that biotechnology has the potential of considerably reducing the economic significance of wild organisms, if life forms of value can simply be engineered in test tubes. We consider this very short-sighted. The genes of wild organisms have mostly undergone millions of years of selection, and of course are almostly ideally adapted to local conditions. Whatever marvels are possible in the laboratory, common sense dictates that the multiplicity and complexity of most natural creations are economically, if not factually, well beyond laboratory synthesis, at least for the conceivable future. In any event, biotechnology enhances rather than detracts from the potential value of biodiversity: the expanded ability to transfer genes to economic organisms means that potentially every living thing represents a source of usable germplasm. It is even possible that the genome of our own species, *Homo sapiens*, may benefit directly from the addition of germplasm from wild organisms, for combatting disease.

If some wild species are as valuable as diamonds, it would seem that they are more deserving of preservation than other species, at least on economic grounds. The viewpoint that some species are more important than others has also been defended on ecological grounds. Species upon which numerous others depend - so-called keystone species, if removed could in theory lead to widespread extinction (Lawton 1991). This has led to the distasteful proposition that a sort of triage should be carried out to save ecologically key species while sacrificing others. Aside from the dubious morality and practical difficulty of providing selective protection for only certain species in nature, estimation of the potential values of wild species is so uncertain that there is presently no reasonable basis for relinquishing any species. We view the need to preserve species of great economic value as inextricably linked with the need to preserve all species.

While we have concentrated on a food plant, it should be emphasized that biodiversity furnishes a diversity of classes of useful materials, such as pharmaceuticals, fibre, wood products, biocontrol agents, pollinators, and a host of industrial raw materials. Indeed, many non-renewable resources, notably petrochemicals, are being replaced by natural plant products. As important as wild germplasm has already proven to be, the potential contributions to agriculture, aquaculture and silviculture are even greater than realized to date. Just which species is likely to be useful for what purpose cannot be predicted with much authority, underlining the necessity of preventing extinction of as broad a range of wild species as possible.

Because one does not know precisely where to find living economic diamonds, and they may easily be obliterated as almost happened to *Zea diploperennis*, it is essential for human welfare that the diversity of living things and their supporting habitats be preserved. Paradoxically, agriculture, as it used to be practised, significantly benefitted surrounding biodiversity (Hampicke 1978). By planting small cultivated plots amidst various landscapes, a variety of transitional habitats were created that tended not only to preserve but also to promote plant diversity. Only in the last few decades has this tendency been dramatically reversed. It is extremely ironic that most of the world's current destruction of habitat is being done to advance agriculture, forestry, and industry, all of which are in danger of destroying bioresources that are critical for their own future progress. Sustainable development of these economic sectors must include respect for surviving habitats that nurture the biodiversity essential for the future.

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## INFORMATION ABOUT THE AUTHORS AND THEIR INSTITUTION

*Drs. Small and Cayouette are research scientists in the Economic Plants Program of the Biological Resources Division of Agriculture Canada's Centre for Land and Biological Resources Research. Dr. Small has published over 100 scientific articles on genera that include crop species such as carrots, hops, marihuana, and alfalfa. Dr. Cayouette is a specialist on Canadian grasses and sedges, and has published many articles on the flora of Canada. The vascular plant herbarium with about 1 million collections, and the plant research library with about 13,000 monographs, are principal components of Canada's research facilities on botanical biodiversity. The economic plants group of six professionals and associated technicians and research associates specialize on systematic research on agriculturally important plants, including crops and their wild relatives, weeds, and rangeland plants, but also carry out monographic research on selected components of the flora of Canada. Other programs of the BRD portion of CLBRR are dedicated to research on arthropods (mostly insects), fungi, and development of Canada's national plant germplasm collection.*

*Illustration of common speargrass,* ***Stipa comata*** *Trin. & Rupr.*
*Common names of this plant are needle-and-thread and common speargrass. The former name refers to the resemblance of the mature fruit to a threaded sewing needle. A grass of dry praries in sandy or stony soils up to the subalpine zone, it ranges from southern Yukon through the Canadian prairies south to the southwestern United States. Like most members of the grass family Poaceae,* ***S. comata*** *helps to protect drier soils from erosion from wind and heavy rains or spring snow melt. Economically, this grass is both a forage and a pest species. Common speargrass is one of the earliest grasses to appear in the spring. Although highly palatable as forage, the hard fruits that emerge in the summer frequently cause injury to grazing animals. Once the sharp-pointed end begins to penetrate skin, stiff hairs pointed away from the end act like barbs so that the fruit cannot reverse its direction and continues to embed itself with each slight movement. Humid conditions in the fall encourage secondary growth of the grass; this can be valuable winter forage.*

***With input from: Jaques Cayouette, Agriculture Canada (Ottawa)***

## *VIEWS*

# Living inventions

## *INTRODUCTION*

The life sciences are changing in their fundamental character, and at a rapid rate. The new biotechnologies have made it possible to transfer genetic material between completely dissimilar organisms and to modify living organisms for human purposes more rapidly and efficiently than ever before.

These technical advances have served to blur the distinctions between living and nonliving and between natural and manmade. Intimately connected with these scientific breakthroughs (to the extent that it is difficult to separate cause and effect) is a strong and escalating trend toward the commercialization of the life sciences. There are large profits to be made, and investment capital has been mobilized in a way unprecedented in the history of science.

Biotechnology requires high levels of investment in research, but the results - the intellectual property - are easily and cheaply copied. Investors in research want some form of intellectual property protection to ensure returns on their investments. Plant varieties have been eligible for protection in some countries for many years using plant breeders' rights (called plant variety protection in Europe).

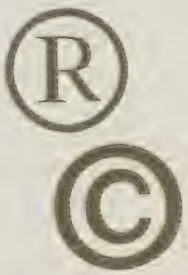
Increasingly, however, industrial-style patents, formerly reserved for inanimate inventions, are being used for living organisms. In most countries where patents are being used for living things, they have been granted as the result of new interpretations of existing legislation and not through new legislation dealing specifically with the issue of patents for life forms.

Patent protection is also available in several jurisdictions, including Canada, for novel genes. As well, the U.S. Patent and Trademark Office has granted patents on a plant characteristic (e.g., High-tryptophan production in maize). The patent claims a monopoly over any high tryptophan-producing maize regardless of the process by which the overproduction is achieved. Furthermore, U.S. law allows that patents may be granted to anyone who "invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof." The argument for intellectual property protection is often couched in terms of increasing incentive to research. Two basic philosophies prevail. The first assumes that without social incentives for the development of useful ideas, in reality incentives for research, there would be less investment in research than is socially desirable. The second holds that intellectual property protection is provided as society's part of a bargain with the inventor. The inventor discloses technological secrets that might otherwise not be made available to society in return for an exclusive right to use and profit from the invention for a specified period of time.

In many discussions, these two notions, of incentive and of reward, are melded together. Intellectual property protection is seen as both incentive and reward for invention and disclosure.

The alternative to effective intellectual property protection is to not disclose information or not make "new" biological materials available to prevent competitors from making use of it. Such "Trade Secrets" can be protected by physical measures of secrecy and by restrictive contracts entered into with employees, users, and others to whom the secrets may be revealed. It is this option that concerns the proponents of strengthened intellectual property protections. They argue that, if research is performed by the private sector, some mechanism needs to be in place to guarantee that the fruits of this research are made available to society.

Although this argument appeals to the need to promote research, the motivations and the pressures currently driving the strengthening patent protection for living entities are much more commercial and trade oriented than they are to promoting an effective research environment; patents are being used to protect investment. This is reflected in the very strong pressures being exerted, especially by the U.S., in bilateral and multilateral trade negotiations, for international "harmonization" of intellectual property protection. Patent protection on living organisms is definitely included.



Potentially more far ranging in its effect is that intellectual property considerations are included as one of 15 negotiating subjects in the current (Uruguay) round of the General Agreement on Tariffs and Trade (GATT). The U.S., European Community and Japan have taken the position that all things, including plants and animals (with very narrow exemptions) should be considered patentable subject matter. Canada, on the other hand, has (so far) taken the position that certain things should be eligible for exemption at the national level (including multicellular life forms and processes for producing muticellular life forms).

## *ETHICAL CONSIDERATIONS*

All countries must face the very real prospect that within the GATT, and within various bilateral trade negotiations, patent protection applicable to higher life forms will be included as an almost incidental part of a much larger commercial/trade package. First of all, it must be made clear that patents were not designed for living inventions. Patent laws were drafted before the advent of technologies that made possible the wide genetic recombinations and other genetic manipulation techniques that are now practiced. The divergence of present practice from the intent of the law is demonstrated well by the difficulties encountered with the disclosure requirements of patent law. Simply stated, patent laws require that an applicant "correctly and fully describe the invention" and the process of making it such that "any person skilled in the art" could reproduce it. That is the deal.

For many living "inventions", however, adequate description is practically or even technically impossible. Even "simple life-forms", such as yeast or algae, are extremely complex. To overcome this difficulty it has become common practice in some countries

to allow the "inventor" to deposit a sample of the "invention" in lieu of a complete patent disclosure. True, the sample is made available for others to use. Allowing a patent applicant to circumvent the disclosure requirement, however, really seems to open the door to patents on organisms that may be novel and useful but that have come about by chance, i.e., the "inventiveness" criterion of the patent may not be met. This does not seem a particularly good bargain for society.

Related to this is a strong "fairness" issue that must be considered. Every living organism is a product of millions of years of natural evolution and, in the case of most domesticated species, considerable human selection and human-induced change as well. Now, by generating a relatively very small change in an organism, it is possible to gain legal control over the exploitation of the modified organism and all of its progeny. What was considered the common heritage of mankind becomes the private property of a few. Intellectual property law is a product of Western society and Western ideals. Other societies have very different concepts of life and of ownership that may not correspond with those inherent in patent policy. These ideas simply have not been explored adequately. In addition, it must be remembered that the innovation systems in many developing countries are quite different from those of developed countries. In many countries, there are strong informal systems, with small-scale farmers, herbalists, and others, developing an enormous range of useful innovations, many of them involving the use of biological materials.

These innovations are not now protected by any codified intellectual property law, and so would be very vulnerable to being improperly appropriated by others in the wake of strengthened, national intellectual property protection. Patent systems may be difficult for the informal innovators of developing countries to use to advantage, but there is a risk that they may be used to their disadvantage. Finally, patents should, as an important mechanism of social policy, reflect a society's ideals and maintain traditional values. Yet patenting living organisms seems to run counter to the distinction that most, if not all, societies make between living and nonliving. The effect is a reduced legal definition of life.

## *COMMERCIAL INTERESTS*

Intellectual property protection and the priorities in biological research are increasingly being dictated by commercial imperatives. Strengthened intellectual property is not solely responsible for this trend, but is certainly implicated as an important element in the privatisation of research.

Where short-term commercial interests dominate, there is clearly a comparative advantage to concentrate research efforts in high value areas. In plant breeding this means species of major commercial importance and which are grown over a large area, generally in the more favoured environments. Minor crops that may be of vital importance to resource-poor farmers in diverse and often harsh environments will inevitably be neglected by commercial plant breeders.

In addition to the concerns about the focus of research, there are also concerns about the way research works. One of the first casualties of intellectual property protection is the free flow of scientific information. Related to this barrier to the free flow of information is the equally important barrier to the free flow of germplasm. If a researcher is allowed to use the patented gene or characteristic, there will be a royalty charge levied. Even if access is not denied, the cost of access will inevitably rise. These types of costs could develop to ridiculous proportions as more and more elements are patented, especially in the field of plant breeding where very wide ranges of parent material are employed.

It is important also to note that in response to the increased physical and legal control (perceived and real) of the North over germplasm originating in the South, there have been threats and actual restrictions on the export of germplasm from some countries. Developments of this kind, although understandable, are in no one's interest. Plant and animal breeders need as wide a genepool as possible to draw on to adapt varieties to changing conditions for the benefit of all.

Meanwhile, as the costs of accessing the necessary material and technologies rise, with royalty payments all around, so too will the cost of "intellectual property management".

The cost of administration and enforcement of a patent system may also be prohibitive. For example, the U.S. spends over $300 million to run their Patent and Trademark Office, and Brazil spends US $30 million on its National Institute of Industrial Property. In the absence of trade pressures, the best strategy for many developing countries would appear to be to not offer patent protection for living organisms and to use instead less strict intellectual property regimes that provide incentives for adaptive innovation. For research purposes, any technology and any germplasm that can be obtained can be utililzed without infringing any laws. Similarly, producers can utilize any materials they can get without paying royalties. However, without protection, technolgy holders will be reluctant to transfer proprietary technology or germplasm (an important consideration for developing countries trying to get access to new technology). Furthermore, harvested materials grown from protected varieties are not exportable to countries in which they are protected; and the trade pressures are a reality.

## *CONCLUSIONS*

In weighing these concerns it is important to keep in mind the ongoing "revision", at least in some quarters, of human relations with the larger environment. This is expressed in a variety of ways, from "deep ecology", through increasing concern for animal rights, to the growing environmental movement. Furthermore, as other countries are brought into Western-style patent systems there will be encounters with a myriad of other cultural perspectives toward ownership of living things. These ideas should be considered as legitimate antitheses to the commercial and trade arguments for patenting.

Alternative forms of intellectual property protection could be designed specifically to deal with the characteristics of living organisms. In many ways, plant breeders rights laws seem to strike an appropriate balance between providing individual incentive and reward for research without seriously skewing the research agenda. Perhaps similar *sui generis* intellectual property protection systems can be designed for other areas of biological research (animal varieties, microorganisms, genes). Another option lies in the petty patent systems employed by some countries that offer somewhat less scope of protection for a less significant inventive step than industrial-style patents. Criteria for such intellectual property systems include offering appropriate incentives to research with the scope of protection limited such that the interests of the larger research system are not compromised too severely in the name of individual research efforts. Still, although modified property protection systems may answer some of the concerns raised here, others - especially ethical concerns - are fundamental to any intellectual property system applied to living organisms.

## *AUTHORSHIP*

*This article draws on information from "A Patent on Life: Ownership of Plant and Animal Research" co-authored by Brian Belcher who was until recently a Research Officer with the International Development Research Centre, P.O. Box 8500, Ottawa, Ontario K1G 3H9, Canada.*

# Canadian Biodiversity Resource Centre: A range of library sources meets a diversity of needs

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The Library and Archives of the Canadian Museum of Nature has established within its collection and services the *Canadian Biodiversity Resource Centre*. The Centre is actively collecting in the areas of biodiversity to build a national centre with information and services available to museums, government departments, academic and research institutions, non-governmental organizations (NGO's) and the public.

The library collection traces its beginnings to 1842 with the formation of the Geological Survey of Canada. Though this Survey's interests were primarily geological in the beginning, they soon encompassed all areas of natural history in Canada. From the Survey through the name and organization changes of the National Museum of Canada and the National Museum of Natural Sciences to today's Canadian Museum of Nature, the natural history collection and its library holdings continued to grow and expand.

Presently, the Library and Archives collection consists of approximately: 70,000 books; 3,200 periodical titles (1,800 currently received). Together these total approximately 100,000 volumes. It includes holdings in botany, invertebrate zoology, ichthyology, mammalogy, ornithology, zooarcheology, paleobiology, earth sciences, ecology and natural history. It has strengths in biosystematics, Canadian and Arctic books and periodicals. This includes Canadian and international holdings. The library also has Rare Book, Nature Art and Photograph collections. Special collections such as the R.M. Anderson mammalogy collection and the C.M. Sternberg paleontology collection have enhanced its holdings. An exchange programme with more than 670 national and international partners, including museums, research institutions, NGO's and universities is actively maintained and we are always willing to consider new partners for the exchange of publications.

In developing the Canadian Biodiversity Resource Centre as a national resource, the library extends access to its collection and reference services to those interested in the many aspects of biodiversity. Interlibrary loan, photocopy and reference requests can be mailed to :

Canadian Biodiversity Resource Centre
Library and Archives
Canadian Museum of Nature
P.O. Box 3443, Station D
Ottawa, Ontario K1P 6P4

or made by telephone (613) 998-3923 or FAX (613) 998-1065. We would also be interested in receiving the names and descriptions of holdings of other libraries with collections covering the many areas of interest included in biodiversity.

*"A town is saved, not more by the righteous men in it than by the woods and swamps that surround it."*

***Henry David Thoreau***
*1817 - 1862, U.S. naturalist & writer*

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# The Rio Summit - Success or failure?

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Not since the creation of the United Nations in 1945 had such a large number of Heads of States been brought together. Under the watchful eyes of thousands of representatives of non-governmental organizations gathered together at the Congress Center in Rio de Janeiro, delegates from 178 countries and over 130 heads of government repeated in turn the creed of sustainable development and negociated agreements in the hope of saving our biosphere. Twenty years after the first United Nations Conference on the Human Environment was held in Stockholm in 1972, much was expected from this Earth Summit that many considered as our last hope.

When all was said and done, most of those present at Rio considered that the Summit brought about net gains for the global environment. But in many ways, it was a failure. Let us examine them and take a look at what the future holds.

## *THE ACHIEVEMENTS OF RIO: SUCCESS OR HALF-FAILURE?*

### ADOPTION OF THE DECLARATION OF RIO

Unable to reach an agreement on an Earth Charter of rights and responsibilities, the Summit participants nevertheless adopted the Rio Declaration, an official 27-clause statement which includes the precautionary principle (under which it will be mandatory for development projects to be submitted to an environmental impact assessment) as well as polluter pays, transparency and equality principles. These are essential components of a true environmental revolution.

### ADOPTION OF AGENDA 21

The Action Plan for a more sustainable 21st century, or Agenda 21, is neither more nor less than a catalogue of means and rules that are to be applied in order to better humanity's quality of life and the health of the environment. That plan covers almost all economic sectors, but completely skirts round the crucial questions of population growth, military spending and the overconsumption of resources by the inhabitants of the northern countries.

### SIGNATURE OF THE CONVENTION ON CLIMATE CHANGE

The main goal of that convention is to stabilize the atmospheric concentrations of greenhouse gases, including carbon dioxide, at a level that would prevent the dangerous change of climate systems brought about by human activities. The signatory countries agreed to limit their emissions of carbon dioxide at the levels of 1990. Even though the lack of precise targets and schedules weakens this Convention, Canada and the European Community announced their intention to reach that target by the year 2000.

Clear cut interests strongly influenced the negotiating process of this Convention. On the one side, the United States delegation and their Texan president, pressed by the powerful coal and petroleum lobbies, insisted on diluting the terms of the Convention. The Arab countries were without doubt guided by the same interests. On the other side, the European countries, caught in the hold of high levels of atmospheric pollution, underlined their committment by counting on the development of their mass transport system and their nuclear energy industry. Canada, torn between the petroleum interests of Alberta and the hydroelectric interests of the Eastern provinces, finally signed the Convention. But it could be seen as a support of Quebec. Ranked as the second most important source of carbon dioxide per capita and the eighth most important source of absolute production of carbon dioxide in the world, Canada must nevertheless take drastic measures to improve its energy account if it is to honour its commitment.

### SIGNATURE OF THE CONVENTION ON BIODIVERSITY

Centrepiece of the Rio Conference, this Convention aims to ensure the nurturing of living species and their protection in order that the resources of the Earth be developed in a sustainable way. It is particularly important in that it deals with intergenerational sharing, sovereignty over the development of biological resources, international aid, technology transfer, property rights, international trade and protection of natural areas and their biological resources.

Canada, Japan, the European Community and most of the developing countries signed and will soon ratify that Convention. Canada did ratify the Convention on December 4, 1992. The United States decided to go it alone by not signing it on the belief that it would endanger some of their industries. Indeed, it will oblige the biological resources users to pay compensatory fees to the countries that own those resources. The users will also commit themselves to share, that is transfer, on request the biotechnologies needed to use or enhance those biological resources.

The Convention on Biodiversity will further a more equitable sharing between North and South while encouraging the sustainable use of renewable natural resources and the protection of living species. Canada should benefit from the signing of this Convention since an important part of its gross national product comes from the direct development of renewable resources. That Convention will also encourage the completion of the national network of parks and the setting aside of other natural spaces as reserves.

**REFORM OF FINANCING PROGRAMS**

The Summit organizers did not manage to get from the North the 600 billion dollars per year deemed necessary to rehabilitate the Earth. The participants nevertheless agreed on the need to increase the sums at the disposal of the Global Environment Facility, a program created in 1990 and managed by the World Bank. Its aim is to help developing countries deal with problems related to the global environment (climate warming, pollution of international waters, destruction of biodiversity and ozone layer depletion). Some countries, including France, have committed themselves to increase their annual contribution to international aid so that by the year 2000 it will reach 0.7% of their gross national product.

**ESTABLISHMENT OF THE COMMISSION ON SUSTAINABLE DEVELOPMENT**

This new Commission of the United Nations is composed of representatives of about 50 countries and non-governmental organizations. It will see to the follow-up of the agreements signed in Rio and to that end, will be assisted by a committee of experts.

**CONVENTIONS TO BE SIGNED**

The participants at the Rio Conference could not agree on the terms of a Convention on World Forests as some developing countries found it unacceptable to limit the development of an important component of their natural resources. There are nevertheless many others that believe that the next conference should do it. The negotiations held in Rio also opened the door to the upcoming signing of a Convention on Desertification.

**THE CANADIAN POSITION AT THE EARTH SUMMIT**

Anxious to show its committment to sustainable development, the Canadian government signed the Convention on Biodiversity and the Convention on Climate Change. Mr. Mulroney also committed Canada to ratify these two conventions by the end of 1992 and to contribute financially to their implementation. Disappointed that an Earth Charter of rights and responsibilities was not adopted in Rio de Janeiro, the Prime Minister proposed 1995, the 50$^{th}$ anniversary of the founding of the United Nations, as a target date for concluding the negotiation of an Earth Charter. He also declared again that Canada would support the adoption of a Convention on World Forests even though an agreement to that effect was not reached in Rio, and reiterated Canada's unconditional support of all the clauses of Agenda 21 dealing with the forests. In order to further the rebuilding of the cod stocks on the Atlantic coast, John C. Crosbie, federal minister of Fisheries and Oceans, took the opportunity while participating at the Earth Summit to promote the implementation of international rules for high seas fishing that would oblige all countries to abide to fishing quotas.

Prime Minister Mulroney also committed Canada to increase its level of international aid, in particular to help the South elaborate sustainable development plans. It will therefore pay its "fair share" of the sums required, over and above the $25 million already committed to the financing of the pilot phase of the Global Environment Facility. Lastly, the Prime Minister promised to speed up the debt write-off process of developing countries and to propose that a Green Round be held after the Uruguay Round of GATT is completed.

## AFTER RIO: A CONCLUSION

Twenty years after the United Nations Conference on Environment and Development was held in Stockholm, the Earth Summit, by its scope, bears testimony to the importance given to environmental concerns on the world scene. Whereas there were only two Heads of State in attendance in Stockholm, there were more than 130 in Rio. As to the journalists in Rio, their number exceeded by far the number of participants at the Stockholm Conference. Whereas industrial pollution was at the heart of the concerns expressed in Stockholm, the Rio Conference was mainly based on world concerns and cooperation. Whereas the East-West conflict was ever apparent in Stockholm, the Rio Conference saw its end and the birth of new divisions. Considered in 1972 as the uncontested leader of the environmental movement, the United States of 1992 is isolated and fingered as the main culprit of the global crisis.

The Earth Summit saw the birth of a new world order. The East-West conflict has given way to a North-South conflict. We were witness to a reasonable level of cooperation between developing countries that try to defend themselves against the "imperialism" of the rich countries and felt some sort of division between the European countries and the United States. The Americans feel that we only need to invest more money to solve environmental problems whereas the Europeans believe that a fundamental change of attitudes is necessary. The Conventions that were signed in Rio are only the first steps in the right direction. Will we reach the end of the road?

In Rio, Canada showed the same leadership that it demonstrated throughout the organization of the Earth Summit. Mr. Maurice Strong, its Canadian chairman who also chaired the Stockholm Conference, and Mr. Pierre-Marc Johnson, a Québécois, were everywhere to be seen. Three other Canadians who brilliantly contributed to the organization of this conference should be mentioned: Mr. Jim MacNeil, secretary of the Brundtland Commission on Sustainable Development, literally wrote the Brundtland Report; and Mr. David A. Munro and Mr. Robert Prescott-Allen, respectively project director and writer of the Strategy for Sustainable Living published in 1991 entitled **Caring for the Earth**. Through their commitment and their work, these committed environmentalists have contributed a great deal to the success of the Earth Summit through their publications.

Well served by the special esteem in which Canada is held on the world scene, the Canadian delegation headed by Mr. Arthur Campeau, special advisor to the Prime Minister, played a crucial role in obtaining the consensus necessary to the signing of the agreements in Rio. The recent adoption in Canada of new policies on the fauna and the forests as well as the implementation of the Green Plan, the St. Lawrence Action Plan and the National Program on Global Climate Change have without doubt contributed to confirm Canada's credibility and leadership at Rio.

The fact that the Canadian government let non-governmental organisations play an important role in the organization of the Earth Summit and be represented on the Canadian delegation are some of the other ingredients that contributed to the success of the Earth Summit. The creation of a trusting relationship between the government and the NGOs opened the door to healthy cooperation between all the parties interested in the goals of sustainable development.

The after-Rio period will be dotted with symposia, technical meetings and working sessions in order to evaluate in depth the achievements and implement the measures adopted by the participants. It is now up to each of us to support the Action Plan adopted in Rio and to implement it in our respective fields of work.

# WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT

## Highlights of the WCED Statement

***Clear and unavoidable next steps, most of which should be taken at Rio:***

* *A broadening of any discussion of population to include the economic and political causes of poverty.*

* *As a minimum step, all countries must provide opportunities for couples to exercise freely their human right to determine the number and spacing of their children [...] some delegations have resisted calls for the universal availability of modern family planning. This resistance is regrettable.*

* *Necessary but not sufficient conditions for sustainable development include prices which reflect full environmental costs and implementation of the Polluter Pays Principle.*

* *Trade must be open to all, particularly to developing nations.*

* *The debt burden is [...] retarding and distorting development...; a further writing down of commercial bank debt is also unavoidable and overdue.*

* *We appeal to governments to conclude for signature in Rio a Climate Convention which contains agreed goals, targets and timetables, funds committed to achieve those targets, and operational machinery to implement and enforce them.*

* *As regards the convention on biodiversity, differences over access to genetic resources and relevant biotechnologies should be reconciled. The issue is survival.*

* *We urge leaders in Rio to launch negotiations on conventions covering forests and desertification. We also call for universal adherence to the UN Law of the Sea Convention, The Basle Convention on the transboundary transport of hazardous waste, and the Montreal Protocol on the protection of the ozone layer.*

* *All aid giving nations should achieve the long-established Official Development Assistance target of 0.7 per cent of GNP by the year 2000. This would allow for implementation of Rio's Agenda 21. The new resources required should not be viewed in traditional "foreign aid" terms; they represent an investment in global environmental security.*

# *NEWS*

## Canada Ratifies Biodiversity & Climate Conventions and Appoints Environmental Ambassador

Continuing Canadian leadership at the Earth Summit, Prime Minister Brian Mulroney signed, on the 4th of December, 1992, ratification documents for international conventions on biological diversity and climate change. Canada is the first industrialized country to ratify both documents. Canada has already begun the process to develop a national strategy and action plan under the coordination of the Biodiversity Convention Office of Environment Canada. Richard Laing of Saskatchewan Environment and Public Safety has been nominated and Brad Fraleigh, Agriculture Canada, appointed, to work with John Herity, Director of the Convention Office, to coordinate provincial and federal government input. There will be input from federal and provincial governments, industry, NGO's, academe and indigenous peoples. Arthur Campeau, Montréal lawyer, Prime Minister Mulroney's "Sherpa", or personal representative to the Earth Summit in Rio de Janeiro in June of 1992, is to be appointed Canada's first Ambassador for the Environment and Sustainable Development.

## Canadian appointed to Senior United Nations Environment Post

Ms. Elizabeth Dowdeswell has been nominated by the UN Secretary-General to be the new Executive Director of the UN Environment Program (UNEP).

The UNEP Executive Director will have a crucial role to play in implementing the results of the Earth Summit. The appointment is part of a broader effort by the Secretary-General to bring in creative and energetic individuals to a revitalized United Nations.

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## Scientific milestone: 4,000,000th plant specimen enters Missouri Botanical Garden Herbarium

What may prove to be an undescribed species of a poorly known African genus, *Ancistrocladus*, was collected in Cameroon by Missouri Botanical botanists commissioned by the National Cancer Institute to collect samples of African plants for testing in their anti-cancer drug discovery program. Preliminary testing indicates that this specimen may have properties of interest to researchers working on HIV treatments. Extensive testing must still be performed; it may take more than four or five years before tests on human patients can be conducted.

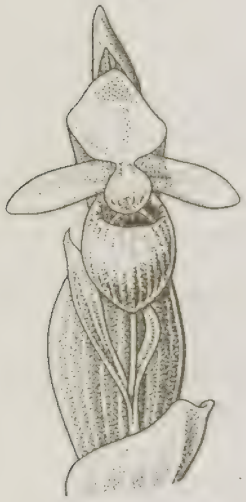
Member of *Ancistrocladus* genus may provide HIV drug

*A woody vine from the rain forests of central Africa with the potential of helping treat diseases such as HIV has the distinction of being the 4,000,000th specimen entered into the herbarium at the Missouri Botanical Garden.*

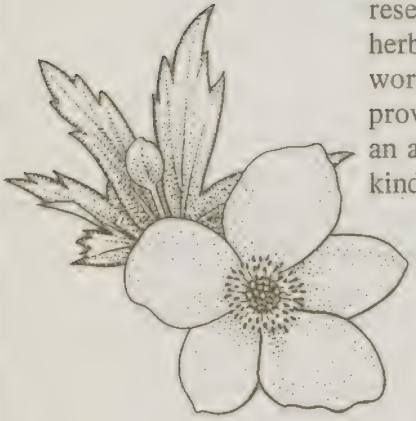
The Missouri Botanical Garden ranks in the top four herbaria in the United States with only the New York Botanical Garden, Harvard Herbaria and Smithsonian having larger collections. (NY ranks first with about 5.3 million.) The Missouri Botanical Garden has 20 plant mounters preparing approximately 105,000 specimens a year for inclusion in the St.Louis herbarium. "The Missouri Botanical Garden has been collecting botanical specimens for more than 125 years," said Dr. Peter H. Raven, director of the Garden. "We are delighted to make this liana, specimen number 4,000,000. The potential benefit derived from this plant -- and from thousands more yet undiscovered in the tropical rain forests makes this an even greater occasion." The specimen was mounted in a protective archival folder during a meeting of the Garden's Board of Trustees. It will be housed in the Garden's herbarium located in the Lehmann Building within the 79-acre St. Louis garden. More than 250,000 kinds of plants (not counting algae or fungi) inhabit the earth. Botanists base much of their knowledge of plants on pressed and dried specimens that have been carefully labeled, mounted, catalogued, and stored in a dry, insect-free environment. Such a collection is known as a herbarium.

The Missouri Botanical Garden has one of the nation's largest herbaria: its collection includes flowering plants, mosses, ferns, and gymnosperms, including some dating back to the middle of the 18th century. The nucleus of the Garden's collection was the Johann Jakob Bernhardi herbarium containing approximately 62,000 specimens purchased in 1857 for Henry Shaw by George Engelmann, a St. Louis physician and one of the foremost U.S. botanists of the 19th century. Given proper care, dried plants stored in a herbarium will last an extremely long time. The Garden's herbarium contains plant specimens collected by George Boehm from the 1740's, by Joseph Banks and Daniel Solander, who accompanied Captain James Cook on his first voyage around the world (1768-71), and by Charles Darwin on his voyage with H.M.S. Beagle (1831-36). These specimens are still as useful to botanists today as they were when they were gathered.

The Bernhardi Collection, assembled during the late 18th and early 19th centuries, contains many interesting and important historical specimens from South America, Asia, and Africa, as well as Europe. George Engelmann's private herbarium of about 100,000 specimens, donated by his family in 1890, contained major collections from many of the exploring expeditions to western North America and northern Mexico during the middle of the 19th century. From this beginning the herbarium has developed into an outstanding international research resource with a major emphasis on the New World and African tropics and western and central North America. Each year the Garden adds to its collection through the exploration and collecting activities of its botanists and those of collaborating institutions. After the plant specimens are collected in the wild, pressed (usually in newspaper folds), and dried, they are sent to a herbarium for identification and eventual incorporation. Here at the Missouri Botanical Garden, they are counted, recorded, and treated to kill insects that might eat the specimens. Labels are prepared from the information in the collector's field book. The plants are then stored in their newspaper folds and arranged by family, and one specimen of each plant is sent as a gift to an appropriate specialist who will identify it and return the correct name. This name is then added to the label information. One specimen of each identified plant is then mounted and added to the herbarium, and the duplicates are distributed to other herbaria in exchange for specimens from their area's activity. The Garden exchanges specimens with some 400 herbaria worldwide.



Part of the task of a botanist is to organize the diversity of individual plants in the world into manageable units which can be named, described, and discussed in terms of their relationships with each other and their role in the ecology of the earth. Most classifications have a common basis: similar things are grouped together. Plants that are genetically related and physically similar and (usually) those that interbreed are considered to belong to the same species. Several different species may have some characteristics in common. Such similar, genetically related species are grouped together in genera (singular, genus), while genera with similar traits are grouped into families. Several thousand new species of plants are discovered and described every year. The plant specimens may have been collected in parts of the world previously unexplored by botanists, although new species are still being discovered every year in areas visited many times by botanists.



Cooperation among the worlds' herbaria is an integral component of progress in botanical research. In addition to the many gift specimens sent to specialists, the Garden's herbarium loans an average of 40,000 specimens annually to researchers throughout the world and borrows about 20,000 specimens for its own staff. The herbarium staff also provides identifications from their area of expertise for other research projects and hosts an average of 500 visitors each year who use the herbarium collection to answer many kinds of questions.

## *1992 Biosystematics Resolution*

The June 1992 Biosystematics Workshop, held at the University of Ottawa, passed the following resolution. In attendance at the workshop and in support of the resolution were representatives from Agriculture Canada, The Canadian Museum of Nature, Forestry Canada, provincial departments and universities.

### *RESOLUTION*

*Whereas biosystematics is the scientific study of the identities, nomenclature, relationships and classification of organisms, and is essential for the assesment, conservation, and sustainable use of biological diversity:*

*As an initial response to our national and international obligations stemming from the biodiversity convention signed at the Earth Summit in Rio de Janiero, Canada should establish a national network linking existing biosystematic expertise, collections and research capabilities in federal and provincial agencies, museums and universities. This should involve a comprehensive analysis of existing capabilities, leading to development of a plan to ensure that requirements for biosystematic information can be adequately met.*

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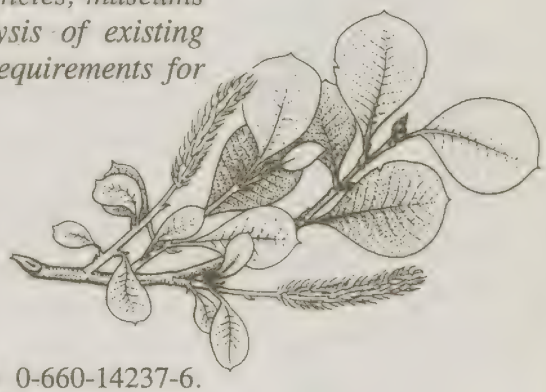


## *Book and Periodical Niche*

**The state of Canada's environment**
Environment Canada 1991. Ottawa. 27 chapters (unpaged). ISBN 0-660-14237-6. Available in French and English Editions. $29.95 + appropriate taxes. Obtainable from: Canada Communications Group, Ottawa, Canada K1A 0S9 by mail, by phone: (819) 956-4802; or by Fax: (819): 994-1498.

In over 700 pages, *The state of Canada's environment* reviews the status of Canada's environment in 1991, adding to, enhancing and updating material found in the report published five years previously. The material was prepared by the State of the Environment (SOE) reporting group, with contributions from over 100 scientists and technical specialists from universities, industry, government and environmental organizations, guided by a SOE Public Advisory Committee (representing industry, environmental, professional and consumer interests). It was a mammoth task to prepare such an overview and a challenge to condense and interpret key information from numerous environments and sectors, each of which could call for a separate book on their own.

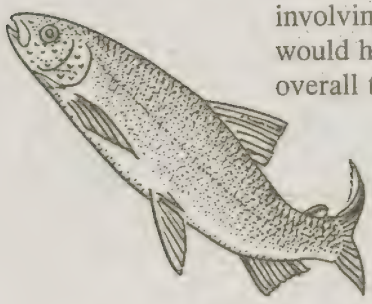
The book is divided into the following parts: Preface, Acknowledgements, Perspectives, Environment and Human Acitivites, Regional Case Studies, Current Issues, Conclusions, Glossary, Units of Measure and Index. The 27 chapters cover such topics as: the Ecosphere, atmosphere, fresh water, oceans, land, wildlife, protected areas, fisheries, agriculture, forestry, mining, energy, urbanization, industries, case studies from the Arctic, lower Fraser River basin, prairies, Great Lakes, St. Lawrence River, and upper Bay of Fundy dikelands. And there are current issues chapters on toxic chemicals, climate change, ozone, acid deposition, solid waste and habitat change.

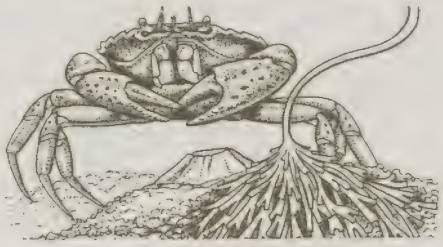
Some samples of material are given to show the breadth and depth of coverage. The lower Fraser Valley farmland provides a rate of return 14 times higher than the national average but is under pressure from urban growth. The soil quality in the valley has declined due to intensive production, heavy fertilization and limited soil conservation practices. Soils are eroding due to exposure to winter rains, soils are being compacted from cultivation when wet, soil acidity is increasing, and runoff from domestic animal production is degrading stream and ground water.

In the fisheries chapter a graph on total commercial and total allowable catch (p. 8-11) shows that commercial catch exceeded total allowable catch in 9 of 16 years from 1975 to 1990. On the Pacific coast salmon stocks seem to be near their historic highs. Catch management seems to be given more attention in the marine environment than habitat change and what habitat change is discussed emphasizes toxic substances. Data is needed on the impact of fishing gear, such as trawls, on benthic habitat and on the effects of bycatch on biodiversity and biological resources. The lack of data in SOE is not solely a concern of Environment Canada, it reflects responsibilities and focuses of other government departments, universities and environmental groups.

In presenting environmental information the SOE group was obviously under pressures from government departments, sectorial industries, politicians and bureaucrats to suppress information or to offer alternate interpretations. There has been the suggestion that some draft chapters were "moderated" before publication. On the other hand there are a variety of viewpoints expressed in many chapters, and some viewpoints are pro-environment. In few countries of the world would sets of such environmental information be collected, let alone published in a widely accessible publication. This is not to obscure that there are shortcomings in perspectives and material. It was a feat to pack so much information into just over 700 pages.

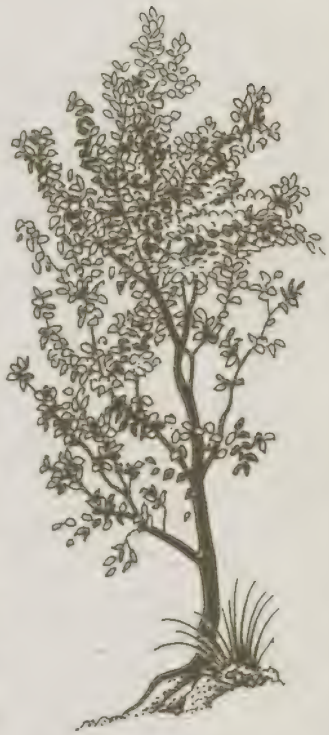
The index contains no main reference to clear cutting forests (look under Forest harvesting - clear-cutting), trawling, drift nets or nets, fungi or mycorrhizal fungi (there is material on fungi), pollination, farms (see Agriculture), or ecological services, involving either an omission of these topics or incomplete indexing. Finer indexing would have improved access to the enormous amount of information in the report. The overall table of contents and the separate chapter contents lists do assist in finding data.





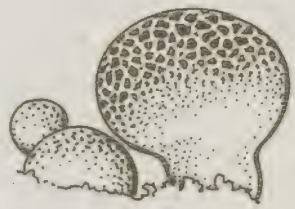
*The state of Canada's environment* is a landmark publication in monitoring atmospheric, terrestrial, freshwater and marine environments. It is a superb resource for anyone interested in the environment. The editing and graphics make it understandable to a wide audience, while maintaining a high technical level. Purchase of this book is highly recommended. And other countries might well look to the process and the product as a potential model for evaluating their environments.

*Don E. McAllister, Canadian Centre for Biodiversity, Canadian Museum of Nature.*

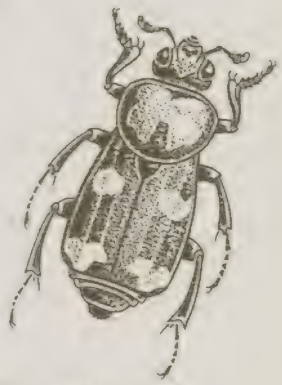


**The conservation of insects and their habitats.**
Edited by N.M. Collins and J.A. Thomas. 1991. 15th Symposium of the Royal Entomological Society of London 14-15 September 1989. Academic Press, London. xviii + 450 pp. US $79.00. ISBN 0-12-181370-3.

This book comes at an opportune time as the subject of conservation or preservation of endangered or threatened species has until recently been focused primarily on large or otherwise visible vertebrates and plants. Arthropods, in particular insects, have received little attention. Yet insects are the most diverse and arguably, most ecologically important, group of organisms on Earth. Current known insect diversity is slightly less than a million species but this is just the tip of the iceberg as any scientist studying the systematics of tropical insects will tell you. No doubt this neglect has been due a variety of factors. First and foremost, we do not know enough about most species of insects to determine which are threatened and thus to determine priorities. Their tremendous diversity coupled with an inadequate knowledge of their taxonomy has made insect identification and classification difficult and for many groups presently impossible. It becomes rather difficult to enact steps to preserve something which cannot readily be named or identified and of which we know little about. Another problem is one of the public's perception of the importance of insects. Because of the habits of a very small number of insect species that feed on human or livestock blood or feed on our crops, most insects are generally and widely imperceived as pests and most people share the view that we would really be better off without them.



Although insects have been generally ignored as far as conservation efforts are concerned, butterflies, because of their visible nature, their relatively well-known natural history and taxonomy, and because many people pursue their collection as an avocation, are an obvious exception. As noted by Paul Opler (Chapter 2), 11 of the 17 insect taxa listed under the U.S. Endangered Species Act of 1973 are butterflies. Of further interest is that all 11 taxa listed are subspecies (or what are effectively nothing more than localized populations of widespread species). In my view, given the rampant destruction of tropical habitats where regional endemism is high and where true and likely very distinctive species are being lost faster than we can count, this is shameful and illustrates a great deal about our efforts and priorities in conserving biodiversity. Preservation of selected and special habitats is the only way to effectively deal with the preservation of arthropod diversity.



This book is the proceedings of a symposium on the subject of insect conservation held at Imperial College in London in September 1989. The book is printed on good quality paper and I could find few printing or like errors. There are 16 contributions which vary

in their subject matter, approach and substance. Regrettably there is no synthesis or summary chapter which could have been used as a vehicle to present the main themes of the symposium, to discuss the setting of priorities, and to collectively offer directives for future action. As in most symposium volumes the subject of concern does not get a balanced treatment. Contributors are from throughout the world but unfortunately emphasis is on Europe and North America with only Australia (3) and Brazil (1) otherwise represented. It would have been desirable to have seen representatives of at least some developing nations present. After all, this is where the bulk of threatened biodiversity is to be found.

Contributions by Opler (North America), Greenslade and New (Australia), Mikkola (Northern and Eastern Europe), and Balletto and Casale (Mediterranean) examine the conservation of insects from a geographic perspective. Generally these contributions discuss the history and current status of programmes directed at conservation of insects in these areas. Substance is variable with Opler concentrating on history and recent iniatives and developments in Canada, the U.S.A. and Mexico; Greenslade and New review the reasons for the special nature of the Australian insect fauna as well as discussing the history and current status of programmes; Mikkola, in a short paper, concentrates on the history and current status of programmes in northern Europe; and Balletto and Casale discuss the nature of the Mediterranean insect fauna, the status of programmes and give a listing of special threatened environments in the region.

Howarth and Ramsay discuss the conservation of island insects (with emphasis on Hawaii and New Zealand) and present a balanced view of the many problems associated with preserving island faunas (primarily the introduction of alien species) which are not common to mainland situations. Dempster examines the effects of isolation resulting from fragmentation of habitat on population dynamics and illustrates this with two butterfly (what else?) examples. Warren and Key, although largely concerned with the ecology of woodland insects consider the history, ecology, management and future of the insects of woodlands in Europe. Erhardt and Thomas discuss the use of Lepidoptera as indicators of change in European grasslands. Foster deals with the conservation of insects, especially beetles, of aquatic and wetland habitats. Usher and Jefferson discuss the creation or re-creation of special habitats for the support of insect life. Dover looks at the conservation of insects on arable farmland. Morris et al. examine the anthropocentric value of non-domesticated insects.

The final two chapters are perhaps the most significant and important as regards conservation of insect biodiversity. These are the papers by Brown on conservation of insects in neotropical environments and Sutton and Collins on tropical forest conservation. Brown's paper is perhaps the most comprehensive in the book, dealing with the history and current status of conservation efforts, the special problems encountered with the conservation of insects as compared to other organisms, a well-defined plan of action, as well as some thoughts for the future. A number of abstracts of poster presentations conclude the book.

The Royal Entomological Society is to be commended for the timely organization of this symposium and for the publication of the proceedings which should serve to stimulate interest and focus concerns. Now, a more balanced and comprehensive treatment, one that offers solid directives and a plan of action, is required, and soon.

*Robert S. Anderson,*
*Research Scientist (Entomology),*
*Canadian Museum of Nature.*

**Annotated List of Ontario Lepidoptera**
By Riotte, J.C.E. 1992. Royal Ontario Museum Life Sciences Miscellaneous Publications. viii + 208 pages. 22.8 cm X 15.2 cm. Available from the University of Toronto Press, Order Fulfillment Department, 5201 Dufferin Street, Downsview, Ont., Canada M3H 5T8. Cost: $19.95 + $3.00 postage + GST (7%).

Faunal lists of species, next to taxonomic revisions, are certainly the most important and widely used publications in all aspects of research in natural history. They are expected to provide the latest information on the systematic, including nomenclatural, status of the taxa treated. If they are annotated to include distribution records, phenology and natural history data, they become even more valuable. The "Annotated List of Ontario Lepidoptera", by Reverend J.C.E. Riotte, shows several imperfections which I shall discuss in the following paragraphs. Firstly, the title of this publication is misleading because at least 25 families (of the so-called "Microlepidoptera") have been omitted on the basis that "they have not yet been sufficiently studied and are not represented by reliably identified specimens in most collections". Since the Canadian National Collection in Ottawa houses extensive and well curated material in most of these groups and that the current curators can often readily evaluate the validity of the identifications, the absence of these taxa in Mr. Riotte's list must be due to reasons other than the ones stated.

The introduction to this work is outdated and superficial to the trained lepidopterist, but probably adequate for the general user. It deals principally with the faunal regions of Ontario and includes useful maps indicating counties, districts, and regional municipalities of the province. The climate is also treated here but to say that "it has been suggested that the climate of Ontario has become generally milder", with references dating back to the 1950s, is irrelevant and useless. The materials and methods section is interesting in that it gives an account of earlier collectors in Ontario, of the main localities sampled by these people, and of the location of the material, with the complete addresses of the housing institutions. The list itself extends over 158 pages. The classification and nomenclature generally follows that of Hodges *et al.* (1983) and the species are listed alphabetically within each genus. When available, vernacular French and English names are given. For some taxa (the butterflies and the larger and showy moths), this is followed by distributional and natural history information. I found this discrepancy of treatment between groups somewhat frustrating.

Throughout the list, without looking very thoroughly, I found several misspellings of scientific names, which, in my mind, should not occur at all in a work of this kind. In addition, the treatment of superfamilies is sometimes inconsistent because families and species are often missing. For example, the Opostegidae and Tischeriidae are inexplicably missing from the Monotrysia for which there is no mention that the group is treated only "in part". And why is the suborder Dacnonypha missing altogether? I counted 1811 species names in this list. This may be considered a fair number but the fauna of Ontario contains at least 1000 more species if I extrapolate from Louis Handfield's unpublished list of Lepidoptera of Québec, which includes nearly 2500 species. One has to keep in mind that Québec has a significantly less diverse lepidopteran fauna than Ontario because it lacks many elements of the Carolinian zone. The taxonomic list is followed by a list of references consulted which, again, shows that the work is incomplete with respect to the groups treated because some important recent publications are omitted, including Bolte (1990), Eichlin & Duckworth (1988), Ferguson (1985), Lafontaine (1987), Landry (1989) and Neunzig (1986, 1990).

The list of references is followed by a very useful index of the scientific names at all taxonomic categories. In spite of the fact that Reverend Riotte's *Annotated List of Ontario Lepidoptera* is basically a list of Macrolepidoptera + the Pyralidae and a few selected groups of "Micros", and that the orthography of the names should be double-checked with other sources in some cases, I think that this book has its place in the library of anybody interested in the faunistics of Ontario Lepidoptera. As Father André Larochelle, famous author of several Québec insect lists, is known to have said: "An incomplete publication is better than no publication at all". Let us hope that the existence of this book will not prevent the future publication of a more up-to-date and complete work.

*Bernard Landry, Biosystematics Research Division*
*Agriculture Canada, Ottawa*

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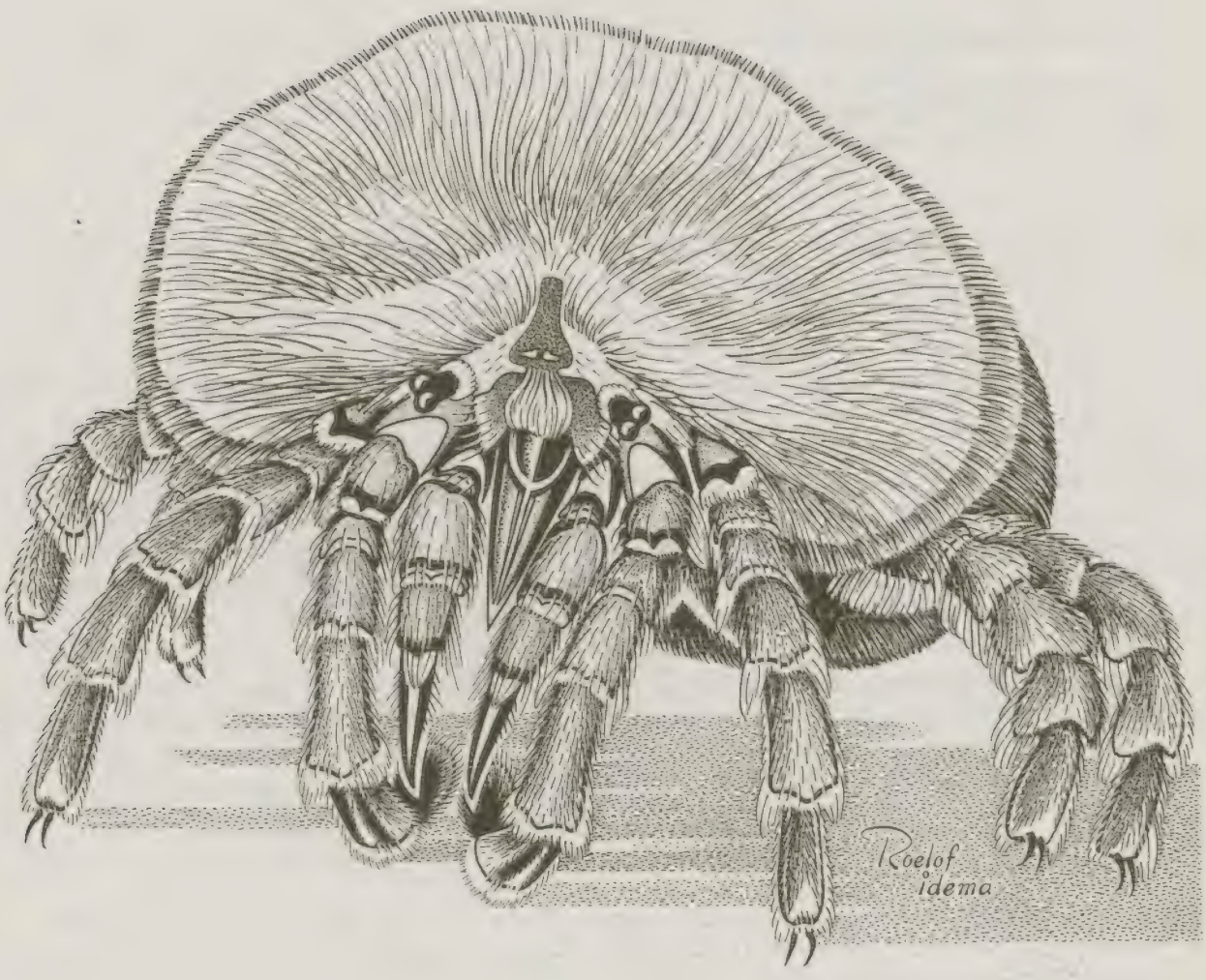


*Illustration of the pea aphid mite,* ***Allothrombium pulvilum*** *Ewing.*
*Larvae of this species are parasites of the pea aphid. The active, fast-moving larvae climb onto the host body and insert rasping, poison-injecting mouthparts into softer areas of the prey thorax. Aphid reproduction is affected by this parasitism; host mortality results when more than five mites feed on them. Adult mites are predators on small soil arthropods. Some species of mites are useful as biological controls of other pest mite species, as well as moderating populations in the wild.*

**Marine Planktology**

By Zhong Zheng, et al. 1989: Springer- Verlag, Berlin, Heidelberg, New York, Tokyo (foreign distributor) and China Ocean Press, Beijing (domestic distributor). viii + 454p, 304 fig. ISBN 3-540-15720-4 and 0-387-15720-4.

This is the English edition of a Chinese book of the same title (Haiyang Fuyou Shengwuxue) by Prof. Zheng and his associates Prof. LI Shaojing and Prof. XU Zhenzu, published by Haiyang Chubanshe (China Ocean Press) in 1984. It is the outgrowth of a course on planktology given by Prof. Zheng at Xiamen University, one of the centres of excellence in oceanography in the People's Republic of China. This book, because of its original role, provides no new concepts in marine planktology but has synoptic information on the research conducted by Chinese marine planktologists during the last four decades and an introduction to the biodiversity of the coastal seas of China.

*Introduction* defines the scope of the subject and discusses general trends of planktological studies in China. The remainder of the book is divided into two parts: *Marine Phytoplankton* (three chapters: Bacillariophyta, Pyrrophyta, and Other Phytoplankton) and *Marine Zooplankton* (nine chapters: Protozoa, Coelenterata, Ctenophora, Planktonic Crustacea, Pelagic Molluscs, Chaetognatha, Pelagic Tunicata, Other Zooplankton, and Planktonic Larvae), with emphasis on the latter (with a ratio of about 4:1 in page numbers). According to Prof. Zheng's preface, the ecology, physiology and biochemistry of marine plankton will be the subject of two forthcoming books.

Each chapter is composed of three sections: *Morphology, Classification*, and *Biology and Significance*. All subjects except morphology and classification of the taxa are discussed under biology. Significance, according to the original terminology used in the Chinese edition, should be economic significance or economic importance. The roles of the taxa in the food web, as indicators of ocean currents, and as food for human consumption are all presented under the umbrella of Significance.

In the Classification, there are diagnoses for different levels of taxa from class to species and keys to the genera of a family and to the species of a genus. Only common genera and species in seas adjacent to China are included in the keys. Only some of the more common species are briefly described, illustrated and have their distribution in Chinese coastal waters noted. The chapters on Coelenterata and Planktonic Crustacea are treated in more detail than other taxa because they are the dominant groups in the marine plankton and also they are of special interest to the authors (Coelenterata for Xu and Crustacea for Zheng and Li).

The Bibliography (for taxonomy, morphology and general biology only) contains 232 references. Almost 50% (115) of these references were published in Chinese journals and, with the exception of three, in Chinese. This book is, therefore, one of the best sources to Chinese literature on marine biology. There is a subject index and a systematic index at the end of the book.

The English of this book is, in general, clear and easy to read. Occasionally one may find a sentence cumbersome but there is no difficulty in grasping the thought that the authors wish to transmit. The proofreading of the book could be improved. Editorial markings (for instance, 1/m on the top of p. 2) left in the final print are unacceptable. I also find it unaesthetic for a chapter to flow without page break into another chapter. All illustrations are taken from the literature but not all sources of illustrations are credited. A large portion of these illlustrations are taken from Chinese publications that most likely have not been seen by readers outside China.

This book is a textbook for Chinese university students and may not be suitable for universities outside China. Nevertheless, I recommend it to libraries of universities and research institutions who are interested in regional flora and fauna, or in the development of marine sciences in the People's Republic of China. It is also an important reference book on biodiversity in the coastal waters of the western North Pacific.

*Chang-tai Shih*
*Research Scientist, Crustaceans*
*Canadian Museum of Nature.*

Reviewer's note - To my knowledge no review about this book has ever been published in the Western World. I found the rich examples of marine phytoplanktonic and zooplanktonic species discussed and the large number of Chinese references given in this book an important source on biodiversity of the adjacent seas of China.

**Butterflies of the Bulolo-Wau Valley.**
By Michael Parsons. 1991. Bishop Museum Press, Honolulu. 280 pp. US $34.95 +$2.32 postage. ISBN 0-930897-61-7.

Butterflies are among the best known insects due largely to their popularity with collectors and amateur naturalists and their attractive and highly visible nature. Although field guides to butterflies abound, few deal with the faunae of tropical regions, an unfortunate circumstance for this is where the bulk of insect diversity exists. This book is a field guide to the butterflies of the Bulolo-Wau Valley, a small but highly diverse tropical region in eastern Papua New Guinea. It begins, as do all field guides, with excellent introductory sections providing basic information about butterfly biology, classification and evolutionary relationships, collection, and quite an interesting and extended discussion on conservation (with of course special reference to Papua New Guinea). A section on butterfly anatomy is lacking but as most butterfly identification is a matter of matching wing patterning and colouration, perhaps such a section is not really missed.

The book covers 373 species, said to be two-thirds of the butterfly fauna of Papua New Guinea. Individual species treatments comprise most of the text of the book and give information on status (common, rare, etc.), size, natural history and habits, and notes on similar species. This last section is quite useful as it draws attention to other species which are likely to be confused with the species in question. In the few instances where more than wing pattern/colour is required for species identification, there are line drawings to illustrate the pertinent features.

There is also a short but sufficient glossary of technical terms, a short bibliography, a list of butterfly foodplants in the study area, and a checklist of the butterfly species. The highlight of the book is the set of 22 colored (660 photographs) and 3 black and white (90 photographs) plates which are grouped near the end of the book. While somewhat small, the photographs are of excellent resolution and should facilitate identification of most of the species. Where necessary for identification, both dorsal and ventral wing patterns and both sexes are shown.

This book is clearly the result of much effort and work, and it appears, extensive first-hand field observations. The author is to be commended; no doubt this book will prove a valuable reference for non-professionals and professionals alike. It makes me want to pack my bags and head for the airport right now.

*Robert Anderson, Entomology*
*Canadian Museum of Nature, Ottawa, Canada*

**1992 Directory of Women in Environment**
WorldWIDE Network, Inc., 1331 H Street, NW, Suite 903, Washington, DC 20005, USA, Fax: (202) 347-1524. 5th edition. 468 pp. US$17.50 for members, $22.50 for nonmembers, plus shipping $5 for USA and $15 international.

People save the environment, as well as degrade it. This book provides names of women and their organizations with whom one can link in joint efforts or who can provide vital information. It will help ensure women and their environmental perceptions are included in the design and implementation of developmental and environmental policies and mobilize and support women in environmental and natural resource programs. 1700 women from over 115 countries are listed.

The book is divided into chapters on Africa, Asia-Pacific, Europe, Latin America-Caribbean, and North America. Within each chapter are subsections for each country, organized in alphabetical order by country and within country by province/state. The women within each country are also arranged alphabetically by surname. These features make it easy to find people.

The entry for each person includes surname with first and second names; country, position/occupation; state/province; organization (if any); telephone, fax and telex numbers; address; education; language usage; services person will provide (e.g. speaker, consultant, instructor); type and level of activity; subjects of activity/expertise. One respondent in Malaysia is described as a Project Officer for a consumer organization, has a BS in Economics, speaks Bahasa Malaysia, English and Tamil, would serve as a Speaker, Project Coordinator or Grassroots Organizer, has engaged in Communications, Community Development, Education/Training, Grassroots Activity, Project Management and Research, works locally, and has expertise in Environmental Education, Environment and Health/Population, Environment and Worker Safety, Pesticides and women.

An index permits one to access the data base by last name, subject of activity/expertise, or type of activity. Appendices list success stories at the Global Assembly, the WorldWIDE International Advisory Council and Board of Directors, Resources on Women and Environment, and a list of direct dial country codes. Printing support was provided by the Canada's International Development Agency and CIBA GEIGY Corporation.

This book will help link the power of women for saving the Earth's environment and life.

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**Beyond the Limits**
By D.H. Meadows, D.L. Meadows and J. Randers. 1992. McClelland & Stewart, Toronto. 300+xix pp. $25.99, ISBN 0-7710-5680-X.

In 1971 "Limits to Growth" by the Meadows and colleagues burst upon the intellectual scene, grabbing the attention of population biologists, social scientists, computer modelers, and the world at large. (Inclusion of "Limits" in the undergraduate course in organismal biology which I taught with colleagues in the early

'70's was indicative of the interest in the work.) Models of aggregate levels of human population and resources using techniques developed by Jay Forrester predicted impending disaster. On account of the importance of the topic and the novelty of the approach, the ensuing discussion was intense and criticism strong, as seen in, for instance, the 1976 "Mankind at the Turning Point" by Mesarovic and Pestel. In the two decades between the appearance of "Limits" and this sequel much has happened: the global degradation resulting from the growth of human population is much in evidence; AIDS looms as an apocalyptic horseman; Paul Ehrlich has lost his bet with Julian Simon; sociobiology, itself controversial but greatly boosted by the such-named tome by E.O. Wilson in 1975, has leavened the tradition of a natural approach to human social issues stretching from the stars of the Enlightenment through Malthus and Darwin to Pearl and Huxley; modeling in futurology is conducted on vastly more powerful machines employing new techniques such as catastrophe and chaos theories; the Brundtland Report has appeared; and an Earth Summit of alarmed nations has been held in Rio de Janeiro.

The present volume opens with an unsurprising dedication to Forrester and to Aurelio Peccei, founder of the Group of Rome, a complimentary foreword by Jan Tinbergen, and a preface reviewing the furor consequent to the appearance of its predecessor. The earlier conclusions are seen in retrospect as basically sound but in need of strengthening. The pertinent epitaphs, lucid text, and ample illustrations convincingly convey the successive stages of the argument: the fundamental problem of overshoot, exponential growth versus the limits of sources and sinks (both renewable and non-renewable), the dynamics of growth in a finite world, ozone as a case of recovery from beyond the limits, the role of technology and markets in overshoot, and avoiding collapse by transition to a sustainable system. Various scenarios are presented using a model whose elements are early explained. References, a glossary, and an index are included.

The authors are clearly aware of issues, such as "garbage in, garbage out", leveled at the earlier work, but there is very little explicit attention to the two decades of extensive literature supporting or criticizing the approach or to specific issues such as fusion energy. Canadians witnessing the belated complete closure of the Atlantic cod fishery this summer will find the analysis of the destruction of this resource particularly poignant. The recommended attitudinal tools to bring about the essential transition bears a striking resemblance to those which have surfaced in other recent discussions, which suggests that a broad understanding of what needs to be done is emerging. The mass media would do well to focus on this book and these tools instead of superficially depicting human suffering as some sort of ineffable super soap opera. This work merits attention of the level which its predecessor generated.

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**Environmental Ethics**

A publication of the Center for Environmental Philosophy and The University of North Texas; Chestnut Hall, 1926 Chestnut Street, University of North Texas, Denton TX 76203-3496. Individual Subscription rates $18 US/year ($6 US/copy). ISSN 0163-4275.

When I first saw an issue of this journal, I thought, "About time." Then, I noted that the journal was already in Volume 13, Number 1 (as of Spring 1991). The journal is dedicated to the philosophical aspects

(about 20 pages each on 14.5 x 23.5cm format, using high quality paper not noted as recycled); and two discussion papers (one of 10 pages, the other of 27 pages).

The articles are written by academics in philosophy, economics or natural sciences, and pose questions as often as provide direction. Perhaps even after 13 volumes, we are still in the "questioning stage." Such questions are posed in the paper on "Environmental Ethics and the Case for Hunting," in the form "is sport hunting a symptom of patriarchy's fixation on death and violence," and "are women closer to nature than men?" The questions are there, the pages of rhetoric which follow may or may not satisfy your desire for direct answers, but a *philosophical* position is offered by the authors.

In addition to the "features" and "discussion papers", two book reviews are given on publications dealing with the philosophy and ethics of environmental issues. The journal is no doubt already an addition to many academic libraries. Perhaps it should also be a part of our politicians' libraries, if for no other reason than to ask the moral and ethical questions about our natural world, our use and our approach to our environment.

Henry David Thoreau remarked: "How watchful we must be to keep the crystal well that we are made, clear! - that it be not made turbid by our contact with the world." October 26, 1853

*David M. Jarzen, Canadian Museum of Nature, Ottawa, Canada*

**Landscape with reptile: Rattlesnakes in an urban world.**
By Thomas Palmer. 1992. Ticknor & Fields, 215 Park Avenue South, New York, NY 10003. xii+340 pp., decorations by Ann Powers.

For purposes of conservation, measures of biodiversity are often weighted to take into account the ecological or taxonomic distinctiveness of some species. Here we have a species, *Crotalus horridus*, the Timber Rattlesnake, which has the distinction that "as the result of two tiny punctures at the base of one's thumb, one's arm quickly swells to the diameter of a six-pound shank ham and large portions of its surface turn red, then purple, then deep blue-black, [so that] one is unlikely to... believe that one's life is not in the balance" (p. 161). This is a species which retreated so rapidly before the commercial settlement of North America that in Canada we only know that it occurred in the Niagara Gorge, though there are many old rumours of "another kind of rattlesnake" in southern Ontario, as far north as Fitzwilliam Island, east of Manitoulin, in Lake Huron.

"This is a love story" (p. xi) about the survival of a population of *C. horridus* in the Blue Hills just south of Boston. Palmer follows a multitude of astonishing threads of connection and irony, and finds there the history of human attitudes towards nonhuman wildness, from the initial European horror to protection of the habitat of an endangered species.

The turning point in this change in attitude came with the mid-nineteenth century establishment of natural history collections by the Boston Natural History Society and the Museum of Comparative Zoology, when "a pickled rattlesnake became a valuable and necessary object, perhaps no more and no less valuable than anything else God had seen fit to produce" (p 127). "*Crotalus* necessarily wore a different face in the wake of the naturalists. Over the years he had done duty as a New World basilisk, an agent of darkness, a dangerous pest, a source of valuable medicines, and, in the revolutionary years, as a sort of American mascot, a model of republican virtues. Emerson had granted him a spark of divinity; for Agassiz he was

a marcher in the procession of life, and exhibited the Parade Master's infinitely painstaking wisdom. Darwin divorced him from his Creator, but made him no less extraordinary for that...

"These weren't all the roles *Crotalus* would play. No one yet had discovered that he was an example of "wildlife", or entered him as evidence in an indictment of modernity. He was still bludgeoned to death more or less wherever he appeared. One of his current uses, as a stick to beat back office parks and condominiums, would have been inconceivable. But he had demonstrated a certain ability to outlast all the guises he was obliged to wear... Before long the very fact of his survival would begin to draw attention. It would look as if he had unaccountably missed his own funeral" (pp. 133-134).

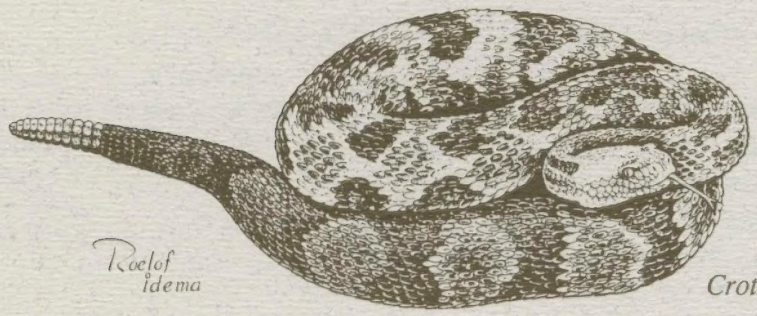
The virtue of this book is the consistent gentle expression of a naturalist's inevitable conviction that the organization of an unsustainable society is pervaded by stupid irony. Skinflint towns paid bounties on *Crotalus* carcases for two centuries, yet Palmer cannot find authenticating documentation of any fatal rattle snake bite in New England. With alcohol or cryo- or stimulant therapy "the truly dangerous stages of an envenomation didn't begin until the doctor arrived" (p. 182), and it is not clear that the modern antivenom therapy is much more (for *C. horridus* bites) than a benign placebo. Abandoned granite quarries in the Blue Hills have killed a dozen youths in the past 30 years; trees killed 146 Massachusetts motorists in 1980 alone.

I noticed few lapses or oversights, all trivial. In 1859, not 1858, Darwin, not "someone" (p. 131), sent Louis Agassiz the copy of the **Origin of Species** that he didn't read. One learns that "blacksnake" refers to *Coluber constrictor* (Black Racer) rather than to *Elaphe obsoleta* (Black Rat Snake) only in the index (on 10 Oct. 1851 Thoreau and a blacksnake had "the first documented encounter in New England between a man and a snake that ended amicably on both sides" p. 145). The reconstruction of rattle snake phylogeny ignores the other genus of rattle snakes, *Sistrurus*. The evolution of snake venoms is scaled to "millennia" (p. 186) rather than tens of millions of years.

The most significant failing is in the panoramic regional map on the endpapers, which does not show the boundaries of towns and reservations needed for fully understanding the text. A figure of Plantain (*Plantago*; an 18th century benign placebo) has irregular non-parallel venation in the leaves (p. 164); otherwise the versal-like vignettes by Ann Powers are entertaining and appropriate.

Every naturalist can tell ironic stories of the foolishness of commercial society's abuse of the land and biota of his territory, but it is a rare delight to have three and a half centuries of such stories told for one population with such thorough scholarship and gentle wit.

*Frederick W. Schueler, Bishops Mills, Ontario*




*Crotalus horridus*

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Brian W. Coad

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**Brian W. Coad** is a research scientist in ichthyology at the Canadian Museum of nature. He has published numerous books and articles on fishes.

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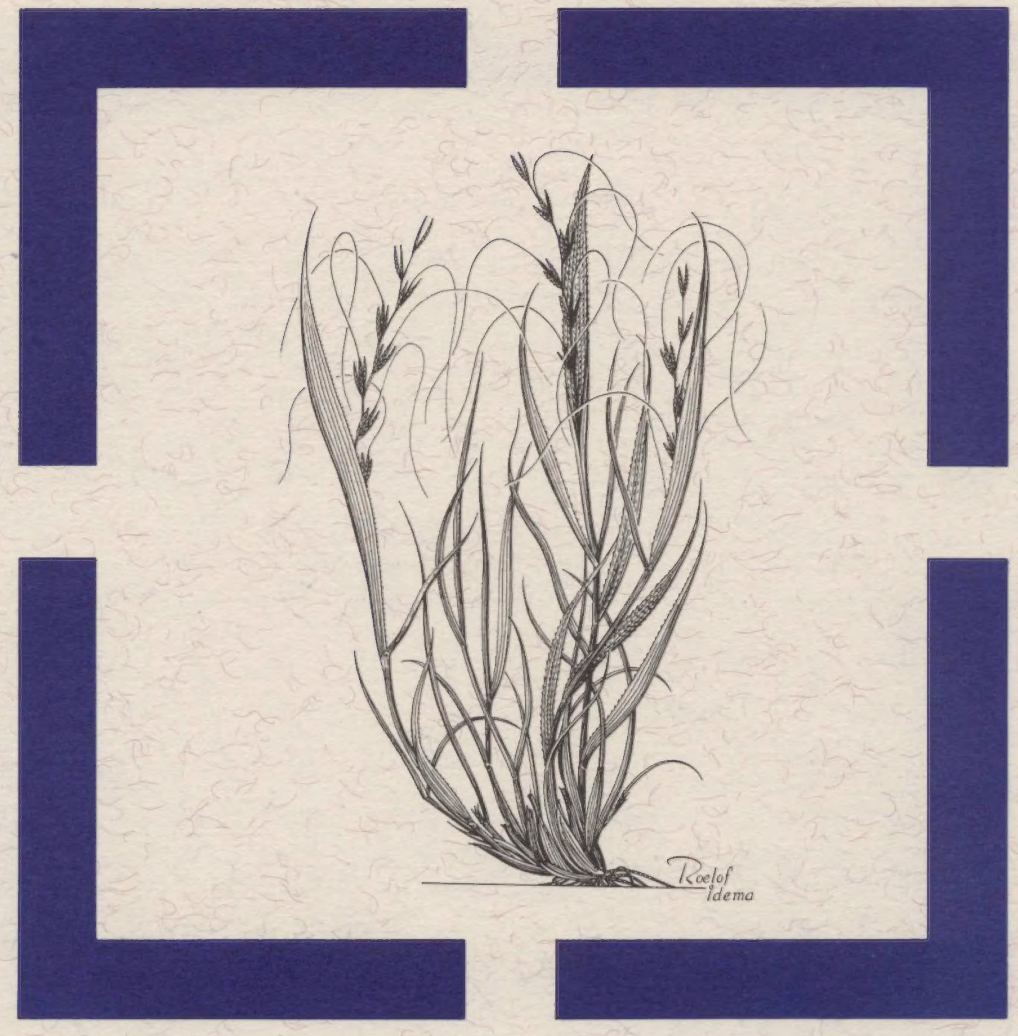


*Towards things that move and plants that grow*
*I with my brush still may steal creation's secrets;*
*Bright sun, a small window, seated alone*
*Spring breeze filling the face - this heart's gentle wonder.*

**Shen Chou**
Chinese painter (1427-1509)

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